DEPARTMENTAL NOTES

INSECTS THAT AFFECT FORESTRY

PREFACE.

THE object of issuing the Departmental Notes on Insects that affect forestry in India in their present form is to enable the Officers of the Department and others interested in the culture of trees to keep up to date with our knowledge of the subject and to assist the advancement of the work by studying the still unknown portions of the life-histories of the various pests detailed and of others still unrecorded. To this end, criticism and discussion are cordially invited.

Several of the insects dealt with are new to science, and most of the information on their habits, etc., is new. It has not been considered necessary here, however, to give in full detail the reasons for the statements made with reference to some of the new and more complex of the life-histories. The author hopes to publish elsewhere full and detailed technical papers dealing with the matter from the scientific standpoint.

It is proposed to give information in these notes upon—

i.—Hurtful Insects.

ii.—Useful Insects.

Owing to queries received on the subject it should, perhaps, be pointed out that the descriptions of the insects do not aim at being scientific ones, they having been drawn up merely as simple aids to identifying the insects by fellow-workers in the field. It is hoped that the new species will be described with the help of scientific confrères. The writer trusts in time to himself deal with the *Scolytidæ*, of which considerable collections of unknown species have already been made.

E. P. STEBBING.

DEHRA DUN,
The 24th April 1905.

PREFACE TO VOLUME I.

THE first number of these notes made its appearance in 1902 and the second in the following year. During the same year a second edition of No. 1 was issued, the first having become exhausted. For this latter edition a revised set of plates, all photogravures, was prepared, the plates issued with the first edition having proved most unsatisfactory. The lengthy period which has elapsed between the appearance of the second and third numbers is due to the work having been interrupted for a period of two years.

Whilst these notes are looked upon merely as a preparatory step towards the publication of a work on the lines of the well-known German *Forst-Insekten* their issue is considered necessary for two reasons:— firstly, they greatly facilitate further research work; for as soon as a considerable number of notes have been collected they are put on record, and with this record as a guide further research into uncomplete life-histories is greatly aided; secondly, they enable those interested in the subject to keep *au fait* with the progress made.

The object and chief aim of the Notes is to prove a real help to the non-specialist workers in the subject, those to whom it is of the first importance to possess a reference work to which they can turn in cases of sudden need: and insect devastation in a forest usually makes its appearance in this sudden form. For this reason it becomes necessary to keep the descriptions of the insects as free from technicalities as possible. This was attempted in its strictest sense in the first part; but it soon became apparent that the number of insects of economic importance in the forest and yet hitherto undescribed (especially in such families as the *Scolytidæ*) was so large that it became absolutely necessary, in order to distinguish closely allied species the one from the other, to give to each a sufficiently lucid description so as to render their identification possible. To avoid all technicalities under such circumstances has proved impossible.

The issue of the Notes would not have been practicable but for the kindly assistance which has been forthcoming on a liberal scale from scientific confrères.

To Lieutenant-Colonel Alcock, C.I.E., F.R.S., I.M.S., Superintendent, Indian Museum, whose kindly advice has ever proved of incalculable value to the writer, to Mr. G. Lewis, F.L.S., Sir George Hampson, Messrs. C. O. Waterhouse, Gahan, and others of the British Museum staff, Mr. Distant, the late Mr. Buckton, F.R.S., the Rev., T. R. R. Stebbing, F.R.S., Mr. E. Ernest Green, Ceylon Entomologist and Mons. P. Lesne of the Paris Museum, Dr. L.O. Howard, and the staff of the United States Division of Entomology, to one and all the author owes a deep debt for assistance in identification work and valued criticisms and advice. Lastly, as the volume will itself show, much information of considerable value contained within its pages is the result of the unstinted aid afforded by the officers of the Forest Service themselves, and with them I would make special mention of the name of Mr. B. Ribbentrop, C.I.E., late Inspector General of Forests to the Government of India, to whose recognition of the importance of the study of this branch of Forest lore we owe its present position.

E. P. STEBBING.

Camp Quetta;
October 1905.

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A further Note on
BRACHYTRUPES ACHŒTINUS, Stoll.

(*Vide* No. 1, pp. 6-9, pl. I, fig. 1.)

Vernacular names. Hind., *Jhingur*; Bengal, *Wechingri* Bombay, *Khaheri.*

This cricket would appear to be common in most parts of India. In addition to the localities already given, the United Provinces, Bombay and Madras Presidencies should be added.

The insect has been reported by Mr. R. S. Pearson as feeding upon teak seedlings in nurseries in the Panch Mahals, in the Bombay Presidency. The method of attack was similar to that already described in No. 1 of these notes.

The following was the method adopted to get rid of the insects :—

Boys were provided with pots of water (a length of bamboo with the top node cut off and the bottom one left on is equally serviceable) and instructed to search for the burrows of the crickets. When found a little water was poured down each. The crickets at once came to the surface and were killed.

SIREX? sp.

Plate XXII, fig. 1.

Classification :—Order, HYMENOPTERA. Family, Siricidæ.

Tree attacked :—*Santalum album* (Sandal wood).

The identification of insects in their larval or grub stage is by no means easy and very often impossible. Perhaps the two families of insects where such identification is possible to a certain extent are the *Cerambycidæ* and *Siricidæ*. To this latter family the sandal-wood-borer under consideration belongs

The following is the description of the larva :—

A thick pale, whitish-yellow grub, convex above and flat beneath. Head small, orange-yellow; mandibles black, rest of mouth-parts brown. Thoracic segments enlarged, the anterior one being hood-like dorsally with a narrow neck of the same circumference as head where it joins on to this latter. Thoracic legs well marked and 3-jointed. There are no abdominal legs, but slight protuberances are present. Abdominal segments nine in number, the terminal one being enlarged, pointed posteriorly and ending in a brown spike which is black at its extreme tip; round its base is a circle of minute brown spikelets. Head, prothorax, and last two segments of abdomen shining. The segments of latter are bulged out at the sides, giving the grub a crinkled edge on either side. Length 1¼ inch. Grub probably not full size. Plate XXII, fig. 1, shows a dorsal and side view of the grub.

Life-History.

Little is known at present about this insect. No member of the family has ever previously been recorded as attacking the sandal tree. The larva was found in the heart-wood of a tree in the first week of August in the North Coimbatore sandal-wood areas and was not, I think, full grown. Unfortunately the wood in which it was found had been so chopped about that its gallery could not be satisfactorily traced in its entirety.

Sirex larvæ usually only bore into dying or dead wood, but require this to be in a sound condition. The female

does not usually require bark to lay her eggs in, but drills a hole in the wood itself and oviposits. These habits render this pest to be feared and make the working out of its life-history imperative, since it is capable of committing damage to the sandal-wood after it has been cut and barked, when no further damage is to be feared from the longicorn borers described on p. 379 and 383.

We require to know how long it spends in the larval stage feeding on the wood, how long in the pupa and adult or fly stage, and when the insect makes its appearance in this latter stage (the adult will probably be a fly not unlike the one shown in Pl. VII, fig. 1 *e* of No. 2 of these notes). Also whether it attacks the trees while they are still quite green or only after the wood has already begun to dry.

When we have answered some of the above questions, more especially the last, we shall be in a position to state what remedies it will be possible to undertake against the pest.

Parasite of *Acronycta anædina*, the Horse chestnut defoliator.

OPHION AUREOLATUS, Cameron.

Plate XX, figs. 1, 1*a*, 1*b*.

Classification:—Order, HYMENOPTERA. Family, Ichneumonidæ.

Parasitic upon the larvæ of *Acronycta anædina*. (See No. 1, p. 91.)

Description.

Cocoon.—The grub spins a cocoon consisting of a yellow matted silk felt in which it pupates. This cocoon is spun inside the lepidopterous pupa and is shown in Plate XX, fig. 1. Fig. 1*a* shows the lepidopterous pupa with a fly emerging.

Imago.—A moderately large bright yellow fly with two pairs of large membranous wings with well-marked veins in them, the upper ones considerably larger than the lower. Antennæ and legs long and slender. The abdomen is joined to the thorax by a very slender peduncle, the body swelling out and thickening considerably in the vertical plane behind this. The segments comprising this thickened portion are curved abruptly and vertically downwards. Horizontal length, ¾ inch. Length taken round curve of dorsal surface of abdomen, 1 inch. Plate XX, fig. 1*b*, shows this insect.

Life-History.

The life-history of this ichneumon probably corresponds, as far as dates of appearance go, to that of its host *Acronycta anædina*, the larvæ of which moth seriously defoliate the horse chestnut in Jaunsar. The caterpillars were excessively numerous in the years 1899 and 1900, and in the latter year large numbers of them were parasitised by this ichneumon. I found very few larvæ on the trees in 1901, their numbers having been practically decimated for the time being by the parasite. Mr. B. B. Osmaston collected a large number of cocoons of *A. anædina* in August 1900 and made them over to me at Chittagong in December of that year. I took them to Dehra Dun and bred out flies in February 1901, the dates of issuing

of some being the 4th, 17th, 27th and 28th of the month. The lower elevation and warmer locality doubtless account for the flies having issued so early in the year. They probably normally issue from the caterpillar pupæ at the beginning of July, which is the period when the moths appear on the wing and lay eggs. The ichneumon fly lays its eggs in the caterpillar and the young grub on hatching out feeds inside the moth larva but does not kill it until it has changed into the pupal stage. Thus the caterpillar completes all the defoliating damage it is capable of accomplishing before it is killed by the parasite. The ichneumon grub becomes full fed about September, and appears to pupate during this month inside the caterpillar pupa. It remains in this condition all through the winter, the fly issuing during the next summer. The anterior end of the larval pupal case splits down to allow the fly to emerge. Fig. 1 shows the pupal cocoon of the fly and 1*a* a fly just emerging from the moth pupal case.

Locality from where reported.

Mr. B. B. Osmaston took this fly in 1900 in the Jaunsar Forests, North-West Himalayas.

Relations to the Forest.

From the above account of its habits it will be seen that this insect is a most useful parasite. Although the grub does not kill off the larva it feeds upon until the latter has accomplished all the damage it is capable of doing, the trees thus suffering heavily during the year of infestation, it nevertheless, when numerous, infests the caterpillars to such an extent that it is practically able to reduce to normal proportions any large increase in the numbers of the *Acronycta* pest. The 1899 and 1900 attacks proved this, the parasite having infested the caterpillars to such an extent during this latter year that it was almost impossible to obtain any moths from the cocoons. In 1901 the insect was very scarce, but few larvæ being found upon the trees. This fact probably reacted upon the ichneumon flies, whose numbers would be in their turn reduced the succeeding year owing to the few caterpillars available in which to deposit their eggs.

Points in the life-history requiring further observation.

1. Where the ichneumon fly deposits her egg. Is it on the external surface of the caterpillar, or does she make a small incision in the skin and place it in this?
2. The number of eggs laid upon any one caterpillar. I have never obtained more than one fly from any one pupa.
3. The number of eggs laid by one ichneumon.
4. The exact length of time spent by the ichneumon grub feeding within the *Acronycta*. Does it pupate immediately after the *Acronycta* caterpillar has done so?
5. Exact period of issuing of the flies.

Some Parasites of *Hyblæa puera* and its variety *nigra*.

GLYPTA sp.

Plate XX, fig. 2.

Reference :—Determined as an undescribed species of *Glypta* by Dr. W. H. Ashmead, of the U. S. Museum.

Classification :—Order, HYMENOPTERA.

Parasitic upon *Hyblæa puera*, var. *nigra*, Steb.

Description.

A small blackish fly with a slender body and many-jointed antennæ. The wings are membranous, irridescent and have a well-developed series of veins in them. A male specimen of this insect is shown in Plate XX, fig. 2.

Life-History.

This ichneumon fly was bred out of some caterpillars of this variety of the Hyblæa which were obtained from the Edakode plantations at Nilumbar on 26th August 1902. The larvæ were kept about three days when they pupated. This ichneumon issued on the 6th or 7th of September, so that its pupal stage would appear to be about a week and may prove to be less. Its larval stage is probably shorter than that of the Hyblæa. The larva feeds upon the caterpillar as an internal parasite, and does not kill the latter off until it has pupated.

PIMPLA sp.

Plate XX, fig. 3.

References :—Determined as an undescribed species of *Pimpla* by Dr. W. H. Ashmead, of the U. S. Museum.

Classification :—Order, HYMENOPTERA. Family, Ichneumonidæ.

Parasitic upon *Hyblæa puera*, var. *nigra*, Steb.

Description.

Resembles the last to some extent. The fly is slender, elongate, blackish. The body in the female, one of which is shown n Plate XX, fig. 3, terminates in a longish exserted ovipositor.

Life-History.

This fly was bred by the writer from the same set of caterpillars as the Glypta, and its dates of pupating and issuing are much the same as the other. Its grub does not kill the caterpillar until the latter has pupated. It feeds upon it as an internal parasite.

The ichneumon fly probably lays its eggs in the young Hyblæa larva.

Note.—I found another form of Ichneumon parasite present upon one of these caterpillars. This was a minute grub which was feeding externally upon the latter instead of internally, as in the case of the two above described ones. The Hyblæa caterpillar was full-grown, but its body was very flaccid and it died within a few hours of my first observing the small prelaceous grub which was at that time small, pale, white, translucent and $\frac{1}{16}$ inch in length. It was first observed on the 26th August. On the 27th it was twice the size it had been the day previously with black specks on its upper surface. It was very active, wriggling about a good deal. It had eaten about $\frac{1}{4}$ of the caterpillar, working from the middle.

The following day the grub was about $\frac{1}{2}$ inch in length, torpedo-shaped, with a pointed yellow head and greyish dorsal surface. Under the microscope it was seen to be a pale yellow green with small white bodies apparent under the skin which appeared to consist of fatty substances It was active and was still feeding upon the caterpillar. It appeared to be nearly full-grown. This interesting larva pupated and then died, and so I was unable to make any further observations upon it. There is no doubt that it commences to feed upon the Hyblæa caterpillar whilst the latter is still alive.

MASICERA sp.

Plate XX, figs. 4, 4*a*.

Reference :—Determined as an undescribed species of *Masicera* by Mquillett, of the U. S. Division of Entomology.

Classification :—Order, DIPTERA. Family, Tachinidæ.

Parasitic upon *Hyblæa puera*.

Description.

Imago.—This insect has a great resemblance to a large house fly.

It is depicted in Plate XX, fig. 4. The insect is brownish-yellow in colour with a blackish head and very short antennæ. The wings are fairly large, and the body stout and hairy. Wing expanse ¾th inch. Fig. 4*a*, shows the black eliptical oval pupal case made by the grub of this insect.

Life-History.

This insect was bred by the writer from some caterpillars of *H. puera* collected in the Karimpoya Plantation at Nilumbur, in Malabar, on the 28th August 1902. These caterpillars were kept for three days and pupated on the 1st September. The fly issued on the 7th or 8th of the month, thus spending a week in the pupal stage.

I am unable to say how long the grub spends feeding within the Hyblæa caterpillar. Only one egg appears to be laid in each larva.

Points in the life-histories of these parasites requiring further observation.

1. In each case where does the fly lay its eggs? Is it on the outside or within the caterpillars?
2. Is more than one egg laid upon each caterpillar by any one fly?
3. How long is spent in the grub stage feeding within the Hyblæa larvæ?

4. Does the fly on emerging at once pair, and do the females soon afterwards lay eggs in the Hyblæa caterpillars? This is possible, since at the period I took the caterpillars they were of all sizes on the teak trees.

5. How many eggs are laid by each fly?

6. How many generations in the year are passed through by—

   (*a*) each of the ichneumon flies?

   (*b*) the tachnid fly?

7. Are these parasites plentiful in years of bad defoliation by Hyblæa caterpillars?

8. Are these parasitic flies present in other parts of India where bad defoliating attacks are experienced from *Hyblæa*. They have at present only been reported from Nilumbur as noted above.

NOTE.—It should prove easy for those interested to breed out these flies by keeping some nearly full-grown Hyblæa caterpillars in a box and feeding them till they pupate. The flies will issue from the pupæ if the caterpillars were parasitised.

Most of my infected caterpillars died, as also did the parasites inside them, owing to the fact that they had to be transported some 2,000 miles up north from Nilumbur just at the time the latter were pupating.

ORYCTES RHINOCEROS, Linn.

The Rhinoceros, or Date-palm beetle.

Reference:—Linn. Syst. Nat., ed. 10, 1758, 346; ed. 12, 1767, 544. Steb. Inj. Ins. Ind. Forests, 37.

See also Circulars on Agricultural Economic Entomology issued by the Trustees of the Indian Museum No. 4—Oryctes Rhinoceros (1903.)

Classification:—Order, COLEOPTERA. Family, Scarabæidæ.

This is the common date and cocoanut palm-borer of Southern India. Its grubs have been reported as feeding upon the roots of young Casuarina seedlings and other trees.

Larva.—A large stout curved grub. Head flat, purplish-brown. Mandibles brownish to black, large and stout; antennæ 5-jointed, basal joint enlarged. On first three segments behind head are three pairs of light-brown, stout, long, 3-jointed legs. Body yellowish-white, last two segments blackish. The head is smaller in transverse diameter than the rest of the body. Body is very thick, corrugated, curved, and swollen out so as to be almost bag-shaped behind. On each side of the third to tenth segments is a large dark-brown spiracle. Body above and below is thickly covered with brown spiky hairs except on last segment, where they are small and scattered.

Length, taken round curve, 4 inches. Breadth $\frac{3}{4}$ inch.

Beetle.—Black, shining, massive and large, with a prominent horn which curves backwards on its head, from which it gets its name of rhinoceros beetle. The elytra are very convex above; the insect being flat beneath. Shanks (tibiæ) of legs armed with spikes, the front ones having each three spikes on their outer edges. A large roughly heart-shaped depression on front portion of thorax. A series of broad striæ and punctures on elytra. Dark rufous beneath with hair of same colour in parts. The beetle is easily recognisable by its form, by its antennæ ending in a series of terminal plates, by its spiked tibiæ and 5-jointed tarsi and great size. Length $1\frac{3}{4}$ inch. Breadth across elytra $\frac{3}{4}$ths inch.

Life-History.

This beetle is to be found on the wing during the greater part of the year. It may hibernate, either as a larva or pupa or perhaps beetle, from November to about March. I have obtained living beetles towards the end of March and as late as the beginning of November. The adult insect spends some time in this state and apparently can do with little food in this stage of its existence, as beetles have been kept for over two weeks without food of any kind.

The insect lays its eggs in dead and decaying palm trees or in masses of palm and other refuse situated in or near palm topes. The grubs on hatching out feed in the decaying trees or in adjacent refuse heaps, and evidently also consume the roots of seedling plants. Mr. C. B. Dawson, District Forest Officer, Kistna, reports that the large grubs feed upon young Casuarina seedlings, being attracted to them owing to the moisture in the sand in which they are planted. These young seedlings are watered whilst in the nurseries and thus the moist layer of sand filled with the young roots would quickly attract grubs of this kind. It is, I think, improbable that the beetles lay their eggs in the nurseries. The young larvæ on hatching out would require something softer and of a more decaying nature as food at first, and would only attack rootlets when their mandibles were stronger and more fully developed.

It is not yet known how long the larva spends in this stage of its existence. It will certainly be several months, since the full-grown grub is of very large size, and it may be considerably over a year. This latter would seem the most probable (unless the insect has several generations in the year, which is unlikely) as from the fact that beetles are to be found almost, if not quite, continuously from March to November, it is evident that the generations overlap, *i.e.*, that at any period it is possible to find eggs, grubs, pupæ and beetles. This, of course, adds immensely to the insect's capabilities of doing damage. The time spent in the egg and pupal stages is still unknown.

Result of attacks.

Young Casuarina seedlings attacked by the grubs at first show signs of wilting and then die off. Only seedlings and very young saplings are attacked.

Protection and remedies.

The following are remedies which have been already recommended for trial:—

1. Employ boys or women to carefully remove the soil round seedlings which are seen to be wilting, and take out and kill the fat grubs found at the roots. This should be done when seedlings are seen to be dying off in any considerable number even at the expense of killing adjacent young plants by thus disturbing their root system. The grubs will go from one plant to another, and one grub may thus destroy a number of seedlings.

2. If feasible, a simple and effective plan is to flood the plantation for a few hours so as to drown all the grubs in the soil. Those that come up to the surface should be collected and killed.

3. Remove all diseased, dead and decaying date and cocoanut palms in the vicinity of nurseries and young plantations. Also, and this is an important point, all refuse heaps of rotting vegetation, etc. If, for the preparation of the nursery, special soil pits of manure, litter and leaves are prepared they should be carefully inspected for these grubs, as the beetles will be certain to lay in such a place. A good instance of the danger of such was noticed in a Calcutta garden in June 1903. The heap of rich soil and humus used for manuring the flower beds contained numbers of the larvæ of this insect which were spreading from them into the beds of young seedlings, whose roots they were devouring. There were palm trees close by.

Points in the life-history requiring further observation.

1. Length of time spent in the grub stage.
2. Length of time spent in the pupal stage.
3. Length of time spent in the beetle stage.

A predaceous Enemy of the Wood-borers *Rhyncholus* sp. and *Hylastes* sp.

NIPONIUS CANALICOLLIS, Lewis.

Reference:—Lewis A. M. N. H., Ser. 7, Vol. viii, Nov. 1901. Steb. Dep. Not. Insec. aff. For. No. 2, p. 248.

Classification:—Order, COLEOPTERA. Family, Histeridæ.

Predaceous upon *Rhyncholus* sp. and *Hylastes* sp. in spruce. Already reported as predaceous upon the Blue pine bark-borers *Tomicus* sp. and *Polygraphus major* and *minor*.

(*Vide* No. 2 of these Notes, p. 248.)

Description of Pupa.

Pupa.—Longish, straight, white with a vertical head and free limbs, wings, etc. Length 4 millim.

Life-History.

A further addition is here made to the notes on the life-history of this Niponius. In the last number of these notes we saw that it preyed upon *Tomicus* sp. and *Polygraphus major* and *minor*. The beetles had been found in the Blue pine chiefly, but also in one instance in some deodar saplings where it was feeding upon *P. major*.

I have now found it preying upon the two wood-boring beetles *Rhyncholus* sp., and *Hylastes* sp., following them into their tunnels in the wood. It was taken in the middle of June in tunnels in a large dead spruce which was being riddled by the above-mentioned Scolytid borers, the former being especially plentiful. Since these two borers are usually found together it is probable, I think, that this *Niponius* also attacks the *Hylastes*: but it may confine itself to the *Rhyncholus* beetles, which it resembles in build. I think there is no doubt that it follows these beetles, into the tree by entering by their galleries, feeding upon them and laying eggs in such a position as will enable the young larva on hatching out to feed upon the *Rhyncholus* and *Hylastes* larvæ.

Niponius canalicollis has now been found in Blue pine, deodar and spruce wood. The insect either spends a long

time in the beetle stage of its existence, or what is, I think, perhaps more probable, passes through a number of generations in the year corresponding to those of its hosts. I have invariably found beetles present in the tunnels of various bark-boring and wood-boring *Scolytidæ* from the beginning of May up to the middle of July.

Points in the life-history requiring further observation.

1. Where the eggs are laid. Is it in the tunnels of the *Rhyncholus* and *Hylastes* beetles?
2. What the larvæ feed upon and length of time passed in this stage and in the pupal stage.
3. The length of time spent in the beetle stage.
4. The number of generations in the year.
5. Where and in which stage the winter is passed through.

Histeridæ predaceous upon various Scolytid bark and wood-borers.

PLATYSOMA DUFALI, Mars.

Plate XX, fig. 5.

Classification:—Order, COLEOPTERA. Family, Histeridæ.

Predaceous upon *Tomicus* sp. (The Blue Pine Tomicus), ? Polygraphus minor, in Blue pine.

Description.

Beetle.—Elongate, narrow, compact, black and shining. The head is provided with stout mandibles and angled brownish antennæ ending in a club. Thorax wider than long, smooth and shining. Elytra elongate smooth and shining in centre, with several well-marked longitudinal striæ down either side; the elytra leave the last two segments of the body exposed, these segments being heavily punctured. Under surface of body and legs brownish. Length $\frac{5}{32}$nds inch. Plate XX, fig. 5 shows a dorsal and side view of this insect.

Life-History, etc.

This insect is to be found in the beetle stage at the end of May at elevations of about 8,000 feet in the North-West Himalayas. It was taken from the galleries made between the bark and sapwood by the Blue pine Tomicus beetle where it appeared to be feeding upon the larvæ of this bark-borer. It may also attack the larvæ of *Polygraphus minor*, of which some were also present in the tree.

There is still much to be learnt about this insect—where its larval and pupal stages are passed, whether the larvæ also feed upon the Tomicus and Polygraphus larvæ, the number of generations of the insects in the year and the time taken to pass through each.

PLATYSOMA sp. nov.

Plate XX, fig. 6.

Reference :—Provisionally determined as an undescribed species of Platysoma by Mr. G. Lewis.

Classification :—Order, COLEOPTERA. Family, Historidæ.

Predaceous upon *Tomicus* sp. (The Blue Pine Tomicus) and *Rhyncholus* sp. in Blue pine. (And perhaps on Polygraphus minor, Steb.)

Also upon *Scolytus major* and *S. minor*, Steb. in Deodar, and *Rhyncholus* sp. and *Hylastes* sp. in Spruce.

Description.

Beetle.—Flat, compact, somewhat elongate, black and shining ; all parts of the insect fit well together. Head is transverse and narrow and provided with stout black mandibles and two elbowed antennæ, each of which ends in a club. Thorax is wider than long, smooth in the centre with a few scattered punctures, these latter more numerous and larger at sides between the two broad shallow striæ. Elytra twice as long as thorax, glabrous medianly with very fine punctures, the sides with three longitudinal prominent striæ, the surface being punctured between them ; the elytra leave two segments of the abdomen and a portion of a third visible dorsally—these segments are constricted posteriorly, the surfaces being finely punctured. Length $\frac{3}{128}$ths to $\frac{3}{64}$ths inch. Plate XX, fig. 6 shows a dorsal and side view of this beetle.

Life-History, etc.

This beetle is to be found in the adult stage towards the end of May. The writer discovered it in some numbers in the galleries of the Blue pine Tomicus beneath the bark of a newly felled tree. The galleries contained pupæ and mature beetles of the Tomicus, and the Histerid was apparently feeding upon them. The width of body of the predaceous beetle exactly fits the Tomicus galleries.

In the third week of the month the beetle was found in some numbers beneath the bark and in the wood of dying girdled blue pine trees. The trees were infested with the Rhyncholus wood-borer (see No. 2, p. 198), and the Platysoma was found in their galleries and also on the sapwood beneath the bark.

This beetle was again found fairly plentifully in the adult stage towards the end of June beneath the bark of recently felled deodar trees which had been attacked by the two *Scolytus* beetles, *S. major* and *S. minor*. These latter with their larvæ were very numerous in the bark and sapwood (see No. 2, pp. 203—212), and the Histerids were feeding upon the larvæ and possibly upon the adults.

A few days later I discovered the same *Platysoma* beneath the bark of a large dead spruce tree, the wood of which was being attacked by the borers *Rhyncholus* sp. and *Hylastes* sp. The Histerids appeared to be feeding upon these.

Locality.

This *Platysoma* appeared to be common throughout the Jaunsar and neighbouring Tehri-Garhwal forests in the blue pine, deodar and spruce zones (about 5,500 to 9,000 feet).

Further observations required.

I have not yet found the larval or pupal stages, and I do not know how many generations this insect passes through in the year. It is evidently not uncommon in the localities above mentioned; but there still remains much to be observed on its habits, and it will be of especial interest to obtain the other stages of its metamorphosis and to ascertain its real importance in the forest.

PAROMALUS sp. nov.

Plate XX, fig. 7.

References.—[illegible]

Classification.—Order, COLEOPTERA; Family, Histeridae.

Predaceous upon Rhynchelus sp.; Hylastes sp., in Spruce and Blue pine.

Description.

Beetle.—A small, compact, elliptical, shining black beetle chiefly remarkable for having a number of spiny hairs projecting from the extremity of the ventral surface of the abdomen.

Head not as wide as thorax, with a prominent depression on either side commencing in outer upper angle and running backwards and inwards to [illegible] but not meeting the hind margin. Thorax with front margin deeply concave. A longitudinal depression on either side of the median line, the surface with prominent and fairly numerous punctures. Elytra nearly cover the whole body, only two narrow segments of the abdomen being visible behind dorsally; the surfaces thickly punctured, the punctures, however, less numerous on either side of the median line. Under-surface black, abdominal segments reddish, with numerous reddish projecting spiny hairs. Legs reddish, with four teeth on outer edge of the front tibia. Length [illegible] inch. See plate XX, fig. 7.

Life-History, etc.

This beetle is to be found in the mature state in the middle of June at about 7,000 feet in the North-West Himalayas. It was discovered beneath Spruce bark in company with the Scolytid wood-borers *Rhynchelus* sp. and *Hylastes* sp., and it is probable that it preys upon them or their larvæ. It was also found some days later beneath blue pine bark amongst a large number of different bark and wood-boring larvæ. It is an active little Histerid with a quick walk. Nothing further is known about this insect. Its larval and pupal stages have yet to be discovered, and the number of generations passed through in the year to be observed.

A further Note upon the Life-history of *Dinoderus minutus*, Fabr.

THE BAMBOO-BEETLE OR "SHOT-BORER."

(Plate XX, figs. 8, 8*a*, 8*b*, and Plate XXI.)

(*See No. 2, p. 172 of these Notes.*)

In a previous number of these notes allusion was made to the fact that this minute beetle had been so often confused with its close ally *D. pilifrons* that it was impossible to make any definite statements upon the subject of its life-history. Since writing those words the writer has been able, during nearly a year's residence in Calcutta, to study with a certain degree of thoroughness the habits of this pest. Lengths of bamboo (Dendrocalamus strictus) cut in the forests of the United Provinces were kept under observation in specially constructed boxes between April and the middle of November, and the operations of the beetles with which they had become infested closely watched. The first interesting and important fact discovered was that the bamboo-boring beetle of Calcutta, or the chief one, was *Dinoderus minutus*. In no instance was *D. pilifrons* found in the bamboos. During my observations I examined thousands of the beetles, but *minutus* was the only one present. This would seem to point to the fact that whilst *pilifrons* attacks the bamboo in Upper India *minutus* takes its place in Calcutta—or, perhaps, it may be said in the hotter, damper parts of the country. A second most important fact is that in no instance have these two beetles been found working together, and the statements extant to this effect would seem to be the result of defective identification. In addition to the observations made upon the life-history and habits of this insect in Calcutta experiments were also conducted, with the object of ascertaining whether it was possible to protect bamboos by impregnating them with various substances. The results attained will be alluded to later on.

the 2nd about 4-5 weeks, from the third week in June to near the end of July; the 3rd 4 weeks, from the end of July to the beginning of September; the 4th less than 4 weeks, from 1st week in September to end of the month; the 5th from end of September to end of October. It is probable that many of the beetles of this generation were caught and killed off by the cold snap experienced towards the end of the month.

Protection.

As detailed in a note published elsewhere * my experiments and observations were initiated in order to enable me to advise the Superintendent of the Government Telegraph Workshops as to how to protect a large number of bamboos which he was converting into field telegraph poles.

I may requote here from my previous note :—

Towards the end of April of this year Mr. Williams, the Superintendent of the Telegraph Workshops at Calcutta, informed me that bamboos which he was converting into field telegraph posts for use on frontier expeditions and elsewhere were being attacked and riddled by insects. The specimens he sent me I identified as the common bamboo-boring beetle (*D. minutus*). As the question of the preservation of bamboos against this insect had been engaging my attention for some time, I immediately paid a visit to the workshops and examined the bamboos. I found that they were being experimentally treated in the following manner before being fitted up as telegraph posts :—

(1) Five days' soaking in river water ;

(2) five days' soaking in a solution of copper sulphate, after which they were dried in a covered shed for several days ; and then

(3) soaked for 24 hours in common Rangoon oil.

This latter has the effect of darkening the bamboos and the smell of the oil remains in them for some considerable time,

* A Note on the Preservation of Bamboos from the attacks of the bamboo beetle or "Shot-borer." Appendix Series, Indian Forester Vol. XXIX, No. 12 (1903).

although not so offensively as to prevent their being made use of. The treatment lasted about 14 days, upon the expiration of which period the bamboos were at once sent to the workshops to be fitted. Mr. Williams had reported that within three weeks of this treatment some of the bamboos had been again attacked by the borers. As some 9,000 had been through the treatment, many of which had been already fitted, the case afforded a good opportunity for experiment. Having carefully examined all the bamboos and their method of treatment I was able, through the courtesy of the Superintendent, to obtain a number of specimens both untreated and in the various stages of treatment. With them it was my intention to initiate a series of experiments to determine the exact effect of any one or more of these preservative liquids as a deterrent to the attacks of the beetles. The bamboos had been cut in the Garhwal Forests (United Provinces) and were obtained by the Telegraph Department at Najibabad, near Bareilly, having been floated down from the forests. They were, following the usual custom, passed through fire and straightened by the merchants before being sold. The telegraph specification required them to be 8 feet long or over, with a diameter at the small end of not less than $\frac{1}{8}$ths inch and not more than $1\frac{1}{4}$th inch. It was known that the bamboos to be obtained were to be cut in the cold weather of 1902-03. Male bamboos (*i.e.*, solid bamboos) only were to be sent. The bamboos were despatched in convenient lots from Bareilly and no special protection was given to them on the journey down. They arrived in Calcutta mostly in February and March, but some in April. They were not subjected to any treatment before the end of February, and consequently some of the bamboos were in the works for nearly a month before being operated upon. The bamboos had therefore either become infested on the way down or in Calcutta itself. When the treatment they were to be subjected to had been decided upon, no time was lost in putting them through it. It was as the last of the bamboos were being put through the preservative treatment, that I visited the works. From previous observations I was of opinion that the beetles then appearing in the works were those of the 1st

generation in the year, *i.e.*, they had developed from eggs laid probably at the end of February or beginning of March. I wished to try and find out—

(1) How many more generations of the beetle appeared in the year.

(2) Whether the oil treatment was of any use.

Experiments.

The bamboos picked to experiment with were good examples of their class of treatment, and on receipt they were placed in boxes constructed of tin foil and provided with close-fitting tops of wire gauze. The boxes were so made that there was no chance of anything inside getting out or anything from without getting in: and they answered admirably. The whole experiment was personally carried out by myself in order to ensure accuracy in the observations. In each box were placed specimens of differently treated bamboos. The experiments were commenced on the 29th April. The following are the results obtained:—

(1) That neither the five days in water nor that immersion followed by a further five days in $CuSo_4$ are of any use as a protection against the beetles. It is true that the first experiments seemed to prove that these soakings were effective, since the bamboos in these boxes had remained unattacked. I attribute this, however, solely to the fact that the pieces of bamboos, selected at haphazard in the Telegraph Workshops and placed in the closed boxes in April, when the beetles were egg-laying, did not happen to have had eggs deposited in them and, consequently, when they were placed in the beetle-proof boxes and protected against the beetles they showed no attacks. All the subsequent experiments with these classes of treatment showed that they are no protection against the beetles.

(2) That the bamboos which had gone through all the stages of the treatment and had received a proper soaking in the oil tank remained unattacked and, in addition, were proof against further attacks by the beetles.

(4) That bamboos cut in the forests between December and February can, even if not treated till between two and three months after cutting (by which time it is probable that many of them will contain eggs) be preserved by the oil-treatment from further attacks of the April, June, July, September and October generations of beetles, each of which attacks means their subsequent riddling by the larvæ arising from the eggs laid by the beetles.

(5) That the oil-treatment, therefore, considerably prolongs the period of usefulness of the bamboo, this period being, as far as the experiments at present show, at least a year.

Plate XXI, 1-4, shows lengths of bamboos which had been put through the preservative treatment and converted into telegraph posts. It was subsequently shown that the reason why these lengths were attacked by the beetle was due to the fact that they were the top ones in the oil tank and had never received a thorough soaking in the oil. In fig. 1 the entrance holes blocked by ejected bamboo wood dust are clearly visible while 2-4 show the damage done to the internal structure of the bamboo by the borings of the beetle and its grubs. Fig. 5 shows a section of a larger bamboo opened out flat to show the attacks of the beetle and grubs. Fig. 6 shows a well-soaked bamboo which had been enclosed for several months in the special boxes made for the purpose, together with several lengths of attacked bamboos. It remained entirely unaffected.

Recommendations.

(*a*) I am inclined to recommend that the soaking for five days in water should be continued since a thick shiny gelatinous substance exudes from the bamboos during this process, and this exudation probably enables the bamboo to absorb a larger quantity of oil than would be otherwise the case.

(*b*) That the soaking in the copper sulphate solution be discontinued, since the experiments have shown it to have no preservative effect against the beetles.

(*c*) That the bamboos be allowed to dry in a covered shed for several days after the water process.

(*d*) That, after drying, the bamboos be soaked for 48 hours in common Rangoon oil.

Cost.

The Superintendent of the Telegraph Workshops stated that the cost of the treatment as carried through by him, *i.e.*, five days in water, five days in $CuSo_4$ followed by several days drying and then two separate soakings (at an interval of a couple of months) of 24 hours each in Rangoon oil, amounts to R3-5 per 100 6-foot lengths, or 6·3 pies per length. This included the labour.

Omitting the $CuSo_4$ treatment and a second soaking in the oil, together with the additional handling involved, should effect a saving in this price, although of course the longer period of soaking in oil will enable the bamboos to absorb more of this substance than they would in the shorter one of 24 hours only.

Concluding Remarks.

In the note previously alluded to I was able to show that, as a result of the oil treatment, the bamboos which had been converted into field telegraph posts remained unattacked up to the third week in November (1903), *i.e.* up to the cold weather, and that during this latter period the beetles hibernate for a couple of months at least. Bamboos are so largely used in India that the prolongation of their usefulness by even a year only would effect a considerable monetary saving. On my return from furlough I wrote, in October 1904, asking the Superintendent of the Telegraph Workshops how the bamboos had fared during the year. He replied that there was no evidence of their having been attacked. Now it is practically a certainty that, had the bamboos remained untreated in 1903, those which escaped serious attack during that year would have been reduced to powder by the end of 1904. Subsequently, at the end of March 1905, I was able to personally visit the workshops. I found that the bamboos treated in 1903 were still unattacked, and that another 30,000 were being put through the treatment and converted into telegraph posts. The treatment is now carried out on the recommendations made, *i.e.*, a first soaking in water and a subse-

quent one of 48 hours in the crude oil. I had already been told by Mr. Truniger, C.I.E., the officer in charge of the field telegraph with the Thibet Mission, that the bamboo field telegraph posts sent up to him (part of the batch of 9,000 converted in 1903) had remained unattacked by the beetle and had answered most satisfactorily, the oil exerting apparently no deleterious effects upon the structure. These posts were returned to store in Calcutta this year (1905), and a careful examination of them failed to show me any traces of beetle attacks: and not only this, but the bamboos appeared to have worn remarkably well. As a result of the experiments and observations made to date we may thus consider that the oil treatment prolongs the effective life of the bamboo by at least two and-a-half years.

APATE JESUITA, Fabr.

References :—Lesne. Ent. Soc. F. Vols. LXV, LXVI.
Bostrichus jesuita. Steb. Inj. Ins. Ind. For. p. 42.

Classification :—Order, COLEOPTERA. Family, Bostrichidæ.

Tree attacked.—Casuarina equisetifolia.

This insect has been reported as tunnelling into Casuarina in Nellore.

Beetle.—Black with parallel sides and a uniform breadth throughout of three-sixteenths inch, perhaps a little less anteriorly and a little more posteriorly. Body more than twice length of prothorax; latter rounded and pitted above; elytra with longitudinal ridges running down their dorsal surfaces with punctures between; elytra deflexed at their apices. Abdomen red beneath. Legs black, short. Antennæ with a club. Length $\frac{11}{16}$ths inch.

Life-History.

This beetle is a wood-borer and bores into the wood of the tree for egg-laying purposes.

It was reported as boring into the trees in June, and therefore the eggs of one of the generations of the year are laid in that month. Nothing further appears to be known about its life-history.

In all probability the beetle does not attack the tree until it is either felled or has from some cause become sickly. The damage is done to the timber, and if the insect is numerous and the wood is required for planks or beams, it would probably cause a considerable loss.

The length of time spent in the larval and pupal stages and the number of generations in the year have yet to be ascertained.

CARYOBORUS GONAGRA, Fabr.

Reference :—Fabr. Ent. Syst. Suppl. 159; Steb. Injur. Insects Ind. For. 49.
Classification :—Order, COLEOPTERA. Family, Bruchidæ.
Tree attacked :—(*Bauhinia racemosa.*)

Description.

Larva.—The larva is a small whitish curved grub.

The *beetle* is greyish or yellowish-brown. It is somewhat elongate, with a small head consisting chiefly of two large prominent eyes; antennæ brown. Thorax triangular, narrower in front than behind, hind margin produced backwards into a point medianly. Elytra wider than thorax, with parallel sides, constricted behind, the apices separately rounded; surfaces striate with longitudinal rows of fine pits down them and covered with short hair. The elytra rest flat upon the large thick body, which is greyish in colour. The most striking characteristics about the insect are the largely developed prominent thighs (femora) of the hind legs; these, as is the case with all the legs, are covered with the fine hair. Abdomen truncate behind. Length ♂ ⅛th; ♀ ¼th inch.

Life-History.

The beetles emerge from the Bauhinia pods at the end of February and beginning of March. The exact position where the eggs are laid has not yet been reported, but it is probable that they are laid on the flowers or young forming pods since the tree flowers between March and June. The larva on hatching out burrows into the pod and lives in one of the seeds, the interior of which it entirely cleans out leaving intact only the external thin brown skin. When full-fed it changes to the pupal state within this brown seed-skin, and this stage would appear to be a short one as larvæ are found in the seeds at the beginning of January. On maturing the beetle bores through the skin and the pod-covering and escapes. This exit hole is usually made near the base of the seed-skin and near one edge of the pod-covering. I have never yet

found more than one of these beetles in any one pod, although there are always several other holes in the pod, the work of other beetles, one of which may perhaps be the male insect. The beetles do not all mature and issue at once, as from pods kept in Calcutta adults issued during the latter portion of February, all through March and April, and on into May.

Locality from where reported.

This insect was reported from the Central Thana district by Mr. G. M. Ryan.

Relations to the Forest.

This insect belongs to a family of seed-eating beetles and it is probable that a certain proportion of the seed of the Bauhinia is lost every year from its attacks. The more serious aspect of the case is that these beetles at times multiply to such an extent that they kill off the whole of the seed of the year. The beetle does not confine its attacks to the *Bauhinia*, as it has already been reported as infesting the Indian Laburnum (Cassia Fistula) seed. It is not unlikely that it will be found to attack the seed of other trees, as it appears to be rather widespread. I was able to identify the insect at the British Museum with the valuable assistance of Mr. Gahan. Two other smaller beetles, *Tribolium castalium* and *T. confusus* are found in the *Bauhinia* seeds, these being predaceous upon the *Caryoborus*. A microlepidopterous grub is also present.

Points in the life-history requiring further observation.

1. Where the eggs are laid. Is it in the flowers or on the young forming fruits?
2. Length of time spent in the egg stage.
3. Length of time passed in the larval and pupal stages.
4. Length of time spent in the beetle stage.
5. In which stage the winter is passed through.

CARYOBORUS sp.

Plate XXII, figs. 2, 2*a*.

Reference :—Provisionally determined as Caryoborus sp.

Classification :—Order, COLEOPTERA. Family, Bruchidæ.

Tree attacked :—*Albizzia Lebbek* (*Siris*).

Beetle.—Resembles the last in shape but is greyish in colour; the elytra leave the last two segments of the body disclosed. The antennæ are short, the thorax small and triangular and the elytra greyish with longitudinal darker markings. The insect is of stout, thick build. Plate XXII, fig. 2, shows a dorsal and side view of the beetle.

Life-History.

The larva of this beetle feeds upon and destroys the seeds of Albizzia Lebbek. These seeds are large, flat and squarish, and are contained in a pod of 9-12 inches in length. The grub completely hollows out the interior of the seed, leaving only the outer skin intact. When full-fed it pupates within the seed. Mr. G. M. Ryan, who forwarded specimens of this insect and the attacked pods, states that the damage done is very considerable. Fig. 2 *a* shows a seed with a mature beetle half-emerged from it.

The beetle issues from the pods, which persist on the tree for a long time, in the hot weather about March-April in the Bombay Presidency and evidently lays its eggs on or in the flowers or young-forming pods in April and perhaps on through May. Only one grub is found within each seed. The pods mature about October and the insect perhaps passes the cold weather season as a pupa within the hollowed-out seed.

The *Siris* tree is very common all over India and Burma, and it is therefore necessary to ascertain whether this insect attacks the seed in this way all over the country.

PLOCEDERUS OBESUS.

DAPORET.

Reference:—Daporet, Dig. Cat. 3 ed., 347. Stebbing, Injur. Ins. Ind. For. 68, Plate III, fig 3. a. b. c.

Classification:—Order, COLEOPTERA. Family, Cerambycidæ. Sub-Family, Lamiides.

Trees attacked:—Sal (*Shorea robusta*); Jhingham (*Odina Wodier*).

Description.

I add the following to supplement the description of the various stages of this insect given on pp. 68-69 of *Injurious Insects*.

Larva.—The larva when quite small is elongate, never curved, white in colour with soft yellowish head and mandibles and twelve segments of nearly equal size. As it increases in size the head becomes yellowish brown, the mandibles large, powerful and black, and the body-segments roundish, wrinkled and thick, the hind ones tapering slightly, the prothoracic one being the largest and hardest. Length 2½ to 3 inches.

The *pupa* is yellowish-white and has the shape of the mature beetle; the elytra, however, are soft, white and curled down on to the breast, the antennæ are held pressed over the back and the legs are pressed against the sides. The eyes are large, prominent and black, the tips of the mandibles also black and the jointed palpi prominent. Length 1½ inch.

Cocoon.—The pupa lies free in a curious, calcareous whitish cocoon, which to some extent resembles a pigeon's egg. These cocoons are to be found lying at the ends of the larval tunnels in the wood of infested trees.

The *beetle* is chestnut-brown in colour above and lighter-coloured below, the legs and antennæ being of the same colour as the upper surface; the head, upper and lower edges of thorax and outer and inner edges of elytra black. The head slopes forward at an angle, the eyes are kidney-shaped, the antennæ taking off from the inner angle of the eye; the first joint of the

antennæ is large and swollen, the remainder long and swollen at the nodes, where they are black; they are longer than the total length of the insect in ♂, of the same length or slightly shorter in ♀. The thorax has a transverse ridge at upper and lower edges and the vertex is covered with small raised irregular transverse ridges; the outer edges are produced into a spine medianly. The elytra have a distinct shoulder to the upper outer angle, the tips being truncate and spined. In the ♀ the last segment of the body projects beyond the elytra. The legs have 4-jointed tarsi, the 3rd joint is deeply cleft in a heart-shaped manner, the 4th joint being inserted in the cleft near the upper end of the third. Length 1¼-1½ inch.

Life-History.

The following observations made in the Siwalik forests in the United Provinces practically complete the life-history of this insect for Upper India.

The beetles appear on the wing in March and soon after pair and lay eggs in the bark of either sickly or freshly felled trees. From these eggs small grubs hatch out in April and feed for a time in the bast layer, making winding galleries in the bark and sapwood. As the larvæ increase in size and their mandibles become stouter they bore down through the sapwood and spend the rest of this stage of their existence in the heart-wood of the tree. About August-September the larva is full-fed and changes into the pupal-state within the curious calcareous cocoon peculiar to this insect (see *Injurious Insects*, p. 68 and Pl. III, fig. 3*c*). This takes place at various depths in the tree. If some of these cocoons are broken open at the end of November, the fully developed beetle will be found inside them, mature but not ready for flight as its outer covering is still soft. The pupal state is evidently a short one, but the beetle on maturing rests within the cocoon between December and March, whilst its outer parts are slowly hardening. If the insect is examined in December, it will be seen that the elytra are still quite soft, and that the legs and antennæ are by no means ready to perform their respective functions properly. The beetle can walk but only in a

STROMATIUM sp. prox. BARBATUM.

Reference:—Provisionally determined as Stromatium sp. prox. barbatum.

Classification:—Order, COLEOPTERA. Family, Cerambycidæ.

Tree attacked:—Casuarina (*Casuarina equisetifolia*).

This is the beetle whose whitish grubs have been reported as committing, in company with the *Arbela*, serious damage to the Casuarina plantations in North Arcot.

Beetle.—♀. A somewhat elongate, narrow, lightly-built beetle of the usual longicorn shape, dark brown with a purplish tinge often merging into a lighter shade towards the tips of the elytra. Antennæ and legs yellow. Former not as long as body. No sculpture on thorax or elytra; both pitted and covered with a fine yellow pubescence. Abdomen yellow beneath. Length seven-eighths inch (varies—may be smaller.)

♂.—Smaller than ♀. Antennæ longer than body. Body narrower and slimmer than in ♀; elytra more lightly coloured on upper half. Length five-eighths inch.

Greatly resembles *Stromatium barbatum*, the Kulsi Teak borer. (*Vide* Injurious Insects, 75, fig. 48.)

Life-History.

Grubs of this insect have been found in the trees in December boring and feeding in the cambium layer and sapwood. In June beetles, said to be the adults of these larvæ, were obtained from the trees. We do not yet know how long these grubs spend feeding in the tree in this stage. It is, however, almost certainly the greater part of a year and may be longer. The pupal stage is probably short.

The damage is done by the grubs destroying the bast layer of the tree. When they are numerous the tree is practically ringed beneath the bark and dies.

Results of attack.

In December 1900 the Divisional Forest Officer, Mr. C. D. Thornton, reported that grubs, identified as longicorn ones "had nearly ruined the Casuarina trees in the Anunundi

Plantation.....The grub is found in the cambium layer, under the bark of old trees, on which it feeds."

At my request for more specimens the beetles here described were obtained and sent me in June (1903), by the District Forest Officer, North Arcot. At present we have no further information about this insect. This beetle has a strong resemblance to the Kulsi Teak Borer, *S. barbatum*, which riddles young teak in Assam.[1]

[1] *Vide* Author's Inj. Ins. Ind. For. pp. 73-76.

LAMIA (?) sp.

Reference:—Provisionally determined as Lamia (?) sp.

Classification:—Order, COLEOPTERA. Family, Cerambycidæ.

This is the beetle whose thick white grubs have been reported as boring into the wood of the roots of Casuarina trees at Cuddalore.

Larva.—A thick whitish-yellow grub with blackish brown head and black mouth parts (mandibles) followed by a largely developed segment which is slightly darker yellow than the following ones. These latter taper slightly to the tenth which is half the size of the prothoracic segment. Last two segments smaller ending in a blunt point. Length 1$\frac{1}{16}$th inch. Breadth across the big segment behind the head (prothoracic segment) $\frac{5}{16}$th inch.

Beetle. — ♀. Black, moderately shining. Abdomen very dark red beneath. A short thick beetle with a vertical head. Prothorax sculptured and spined above and at sides, widest in middle. Joined on to the elytra (wing covers) by a short neck. Elytra wider than hind portion of prothorax, parallel to near apex where the outer edges turn inwards, the elytra thus terminating in a blunt point. Elytra entirely cover the base of body. They are corrugated and spined at their basal portions and pitted strongly for the rest of their length. First joint of antenna is swollen and well marked. Length thirteen-sixteenths inch.

Life-History.

We know little at present about the life-history of this insect. The grubs attack and live in the cambium layer and sapwood of the roots of the tree and are said never to be found in the stem. Grubs were found in this position on the 1st June, and one mature beetle was obtained from the Tálaukoda Plantations near Cuddalore. There are no records as to the amount of damage this beetle commits. Since it lives in the cambium layer of the roots it is likely to prove a very serious pest when present in any numbers in a plantation.

Protection and remedies.

Until more is known about the life-histories of these two Cerambycid beetles, it is difficult to prescribe remedies against them. Badly infested trees should, however, be cut out whilst the insect is still in the grub stage and the bark stripped off so as to expose the cambium and sapwood of the tree to the sun. In this position the grubs and pupæ will soon be killed off and will never reach the beetle stage. This must be done whilst the insect is still in its larval stage. If left too late the beetles will begin to emerge and many will escape and lay eggs in adjacent trees.

The same applies to trees whose roots are attacked. The earth should be removed round the larger of these latter, since it is in these that the grubs will be found, and the bark be then stripped off.

Points in the life-histories requiring further observation.

1. Where the eggs are laid by the beetles.
2. When do the young larvæ hatch out?
3. Length of time spent by the larvæ feeding in the cambium layer and sapwood.
4. Length of time spent in the pupa stage.
5. When does the beetle emerge? Is it only towards the end of May and beginning of June, or do beetles appear at other periods in the year?
6. Does the *Lamia* grub also attack the stem of the tree?

Sandal-Wood-Boring Insects of Madras.

References have been made at various times to the damage done to the sandal-wood trees in Madras by wood-boring insects. In 1891, a considerable loss was experienced in Mysore owing to their depredations. As is well known, the wood of this tree is particularly valuable, and when it is mentioned that the least blemish (and the old gallery of a wood-boring insect is considered a very serious one) reduces its value from 1st class (₹850 per ton) to 3rd (on ₹750) or 4th (₹700) or lower, it will be readily understood that it is of the first importance to know something about the life-histories of these insects and what measures are feasible to counteract their attacks.

The insect which up to the present has been quoted as chiefly responsible for these attacks[1] is the caterpillar of the moth *Zeuzera coffeæ*, Neitner, a species which also infests the coffee. Careful observations on the ground have shown me that this belief is erroneous. Such species as have been sent to the Indian Museum for identification of the pest have been naturally small, and consisted probably entirely of branch-wood or small tops. These are the parts of the trees which the caterpillars of the *Zeuzera* prefer. It is, however, the heart-wood of the main stem and the large branches that is of commercial value, and this is attacked by quite a different class of borer. It is a beetle grub belonging to the family *Cerambycidæ*, which contains some of the largest wood-boring insect grubs known. I can find no account of these having ever been reported as damaging the wood, and yet they are undoubtedly the main cause of the loss experienced. One specimen of yet another class of borer, the sirex already described on p. 337, was found in the heart-wood of a tree. These borers were taken in the North Coimbatore forests.

[1] Indian Museum Notes, Vol. III, 1, 1.

STROMATIUM ? sp.

Plate XXII, fig. 3.

Reference :—Order, COLEOPTERA. Family, Cerambycidæ.

As has been already mentioned the identification of insects in their larval or grub stage is by no means easy. I am of opinion, however, that the one found boring in sandal-wood stems may prove to be that of a species of *Stromatium*,* a genus belonging to the *Cerambycidæ* family of beetles. Throughout the sandal-wood areas of the North Coimbatore forests this insect was by far the most aggressive pest of the tree. I have as yet been unable to obtain any beetles of this sandal-wood-boring grub, of which the following is a description :—

Larva.—White with a pinkish tinge, thickish, tapering slightly behind. Elongate, consisting of a small head and 12 following segments. Mouth parts black. Thoracic segments (the 3 segments following the head) yellowish. Length 1 inch to 1½ inch. Plate XXII, fig. 4, shows this grub.

Life-History.

Grubs differing in size but from two-thirds to nearly full-grown were found in galleries in the stems of the trees in the first week of August. No small larvæ were found. From their total size and the length of the galleries bored, and from the fact that no young larvæ were found in the stems examined, I should think it improbable that they spend over a year in this stage and the period may be a few months only. Neither the pupal nor beetle stages of the pest have been yet found.

Method of attack.—The larvæ are to be found either in the main stem or the small branches. An examination of these latter shows that the grub has often started in the branch and then bored down it to the main stem and then down the latter. This is not invariably the case, as at times the larval gallery is entirely confined to the main stem. From this it is evident that the eggs are laid by the beetle on the bark of

Vide Injurious Insects of Indian Forests, pp. 73-76, figs. 47, 48, 49.

either a branch somewhere close to the main stem or on the main stem itself. These observations are the result of an examination of a number of trees and saplings, some of which were entirely cut up for inspection purposes. The tunnel is tightly packed with the digested wood particles which are passed out by the larva as it proceeds down the stem. These galleries are chiefly confined to the heart-wood of the tree, both in the branch and main stem, and the grub always bores downwards.

Before changing to the pupal state the larva enlarges the gallery slightly, and fills the extreme end with particles of wood refuse and chips. It then turns round in the free space and changes into a pupa. The beetle on maturing bores its way out of the tree by a horizontal hole driven direct through the heart-wood, sapwood and bark to the outside. The position of this exit gallery with reference to the larval gallery inside makes it evident that the larva turns round in the pupating chamber before changing to the resting stage. Whilst boring its gallery the larva may eat out one or two offset galleries to the outside. These are always at right angles to the main gallery and are for aëration purposes only. When the larval gallery is confined to the main stem there will usually be only one of these. If the gallery has started in a branch there will often be two. The insect would appear to confine itself to saplings and young poles.

Between Dhimbun and Kollegal a number of trees and saplings were found to be attacked. The following is a description of a badly infested one which, together with others, was entirely cut up. It is quoted as indicative of what this borer is capable.

The tree had a diameter of 2½ inches at the base and a bole of 15 feet to the point where the crown commenced. This bole had been attacked in several places, the last gallery running down to within 3 feet of the base of the tree. Both new and old galleries were visible upon splitting up the stem. These were as follows, beginning at the lowest one:—

1st—New Gallery.—Contained a living grub just about to pupate in the heart of the stem. Gallery about 18 inches

in length bored downwards and confined to the stem only. Gallery slightly winding.

2nd—Old Gallery.—The eggs were probably laid upon the bark of a side branch. The gallery commenced in this. The young larva on hatching out had bored straight to the heart of the branch and then bored down its centre till it reached the main stem, down the heart-wood of which it carried its tunnel. Length of gallery in main stem 7 inches. The larva had pupated at the end of the gallery, the extreme end of it being packed with wood chips. The rest of the gallery, with the exception of the pupal chamber, was blocked with a dark red hard mass (the heart-wood is reddish) consisting of chewed wood. A large hole starting at one side near the upper end of the pupal chamber was bored horizontally through the wood to the outside. This exit-hole was very visible on the outside of the stem.

3rd—Old Gallery.—This one also commenced in a side branch, the larva working down the branch into the main stem and then down the centre of this latter, finishing up close to where No. 2 joined the main stem. It did not join this latter. Length about 1 foot. An air-hole had been bored to outside. Exit-hole of beetle bored in the same way as in No. 2.

4th—A New Gallery.—Contained a living larva which was about to pupate. It had enlarged the end of its gallery for this purpose. About 3 inches of the gallery was free of the compressed wood excreta. Length of gallery 11½ inches. Was confined to centre of the stem and contained one air-hole bored to outside about half-way down. In this case the egg must have been laid by the mother beetle either on the outside of the bark in a crevice or in the softer layer of tissue below.

5th—Old Gallery.—This gallery started at the point where the main stem branched into two or three forks, *i.e.*, where the crown commenced. It began about 1½ inch

up one of the forks and then came down the main stem, its total length being from 15 to 16 inches. One air-hole present. This gallery ended near where No. 4 commenced.

6th—New Gallery.—A tunnel containing a living larva which ran down one of the forks and ended very near where No. 5 joined the main stem. The grub inside was not more than ½-¾rds grown, and the gallery appeared to be still in course of construction. It was apparently on its way to the main stem.

From the above we see that there were no less than five tunnels in the main stem (two of which contained living grubs) and one unfinished one in a fork of the crown near where it joined the bole. The tree was alive but badly stag-headed. It was growing near Osahatti, in the sandal-wood coupe No. 7.

Results of Attack.—Only living trees are attacked by this pest, and it would appear to confine itself to saplings and young poles. The sandal is not necessarily killed by the action of the boring grubs; in fact, unless these latter are numerous the tree is probably but little inconvenienced and the cambium layer soon covers over the old air and exit-holes made by the pest. In such cases there is no evidence externally that the tree has been attacked. When it is felled and converted, however, the heart-wood is found to contain the old galleries, made by the boring grubs which infested the tree when young, and the value of the wood is thereby greatly lessened, no matter how fine in quality it may be. At other times, however, the tree shows externally plenty of evidence of old attacks. The air-holes and exit-holes are plainly visible, and if the sandal is from any cause sickly and unable to cover these over they begin, under the action of the sun and rain, to "weather," become greatly enlarged and even at times coalesce. When the latter takes place the tree will be found to have its centre exposed on one side, perhaps for a distance of several feet, and a considerable amount of "heart" wood will have rotted away under the "weathering" action.

The plantation at Bailur was visited and inspected. The poor character of the growth here was due to other causes, but

it was apparent that a number of the trees had been attacked some years previously by a cerambyx borer, not improbably the *Stromatium*. About 4,000 badly shaped or dying and dead trees had been cut out the year previous to my visit (1901) or it is not unlikely that the evidence of the pest's work would have been still greater.

Summarising the above we see that this pest may—

(1) Kill saplings (probably not often);

(2) Bore up the heart-wood of young living trees. That subsequently the vitality of these latter is sufficient to grow over the air and exit-holes, thus hiding all trace of the attacks which are only discovered when the wood is converted for sale.

(3) The exit and air-holes may "weather" to such an extent that they coalesce, and thus 50 per cent. or more of the heart-wood of the tree may be destroyed.

During a visit I paid to the Sandal Koti at Bangalore, I was able to inspect the damage done to the wood by these insects. Unfortunately I arrived a week too late to be present at the actual sorting of the year's outturn which was stored in the godown. Had I been present at this it would have enabled me to have inspected many hundreds of logs, and it would have been possible to form some conclusion as to the insects' abundance or otherwise in Mysore. I was shown the various classes of wood and the system of classification was described. Wood with holes and galleries in it, even though its quality may be otherwise absolutely 1st class, is relegated to the 3rd or 4th classes, and therefore it is quite possible to calculate the actual monetary loss occasioned by the work of this longicorn. My inspection showed it to be sufficiently high to render the full working out of its life-history a matter of the first importance.

NOTE.—In a tree with a diameter of 6 inches at the base I found another kind of longicorn larva which is not a *Stromatium*. The tree, a large one standing in the Odayarpalaiam compartment of the Doddasanpige Forest, had a dead 5 foot top. Below this in the green wood I cut out a longicorn grub, about 1¾ inch long, white but with much larger thoracic segments than has a Stromatium larva. A second one was found lower down in the bole. Nothing further has been ascertained about this grub. It would not appear to be so numerous as the *Stromatium*, as only

three specimens of it were found. The heart-wood of this tree, a particularly fine one, was greatly reduced in value by the numerous old and new galleries it contained.

This longicorn may be identical with the well-known "white borer" of the South India Planters. This latter grub is the white larva of the cerambycid beetle *Xylotrechus quadripes*.* The grub is shown in Plate XXII, fig. 4.

Distribution.

This borer and the *Zeuzera coffeæ* (*vide* p. 435) exist in the sandal-wood areas of North Coimbatore. The Deputy Conservator of Forests at Bangalore, to whom I explained with diagrams the nature of the damage done, told me that he thought these two were also present throughout Mysore. He could not tell me anything about the sirex borer. From an examination of the sandal billets in the sandal Koti at Bangalore, I think that there can be little doubt that the Deputy Conservator is correct. I have at present no information as to whether these borers exist in Coorg.

Protection and Remedies.

The question of methods of protection against these internal boring pests is a difficult one, and the drastic one of cutting out and burning all infested trees is often the only one that can be recommended. The matter is rendered more difficult in this case owing to the scattered way in which the sandal grows.

We require to know a good deal; more about the Stromatium's life-history and, firstly, the period at which it lays its eggs and how long they take to develop and hatch out the grubs. If the beetles all issue at approximately the same time and lay their eggs on the bark within a period of a fortnight or so, it would be quite possible to make an attempt to check the pest in localities where it is seen to be bad by scraping down the bark of the trees with a blunt instrument. This would get rid of the eggs and save the tree. I recognise that there would be difficulty in doing this owing to the fact that the sandal usually grows in the midst of thorny scrub bushes. In the case of severe attacks, however, it would be quite feasible and the value of the tree would justify the expense. It is, therefore, of great importance that the periods of emergence of the beetle and egg-laying should be ascertained. Trees infested are not so

* *Vide* Note in Injur., Ins. Ind. Forests, p. 80.

easily recognisable as in the case of the red borer, as the white one packs its tunnel with wood excreta as it progresses forward and does not eject this. It will be remembered, however, that it also bores air-holes to the outside, and these can be recognised in the same way as those of the red borer. Further we have seen that a tree infested in previous years is liable to be attacked again in a succeeding year. So it would be well to remove those in which air-holes and fresh exit-holes are present.

A study of the predaceous and parasitic insects which prey upon the larva should also prove most useful.

Points in the life-histories requiring further observation.

1. Exactly where and when the beetles emerge and egg-lay.
2. The period occupied in egg-laying. This period will coincide with that during which the beetles are to be found upon the wing.
3. The period passed in the egg stage.
4. The period spent by the grub boring in the wood. Is this less than a year?
5. Length of time passed in the pupal stage. Since I found grubs full-fed and about to pupate in the first half of August, one of two things may occur—
   (*a*) The pupal stage may be a short one, and the beetles may emerge in September or October and lay their eggs upon the bark at once, and the cold weather may be passed through in this stage—the larvæ hatching out in February or March, probably the former, or
   (*b*) The insect may remain in the pupal stage throughout the cold weather, or
   (*c*) The beetle may become fully developed before the cold weather, but remain in the pupal chamber throughout the cold weather emerging about February.
6. Length of time spent in the beetle stage.
7. What predaceous and parasitic animals prey upon this borer?

CALANDRA SCULPTURATA, Gyll.

Plate XXII, figs. 5, 5*a*, 5*b*, 5*c*.

Classification :—Order, COLEOPTERA. Family, Curculionidæ.

Tree attacked :—*Quercus incana.*

Description.

Larva.—A small, white, short, stunted, legless grub, almost as broad in the centre as long, with a small pale-brown head. Length $\frac{3}{16}$th inch.

Pupa.—White, of usual weevil type and about same length as larva.

Beetle—Has the regular weevil shape. On first emerging from the pupal state it is red in colour but soon changes to a dark red brown. The whole surface is covered with small punctures. The proboscis is curved and about $\frac{1}{16}$th inch long. The antennæ are elbowed and spring from near the base of proboscis. Thorax covered with punctures, irregularly scattered. The tibiæ of the legs are ribbed and bear a hooped spine, and the punctures are in longitudinal rows. The elytra do not quite cover the abdomen and have broadly rounded ends. They are ribbed and the punctures are arranged in longitudinal rows, about fourteen rows on each elytron. The elytra are about half the length of the body. Length $\frac{3}{16}$th inch exclusive of proboscis; proboscis slightly over $\frac{1}{16}$th inch. Plate XXII, figs. 5, 5*a*, 5*b*, 5*c*, show the larva, pupa and imago of this weevil, and also an attacked acorn.

*Life-History.**

This weevil first begins to emerge from the acorns about the middle of June and continues doing so until the end of the month. Mr. B. O. Coventry, who discovered it and studied its life-history, is of opinion that it probably immediately lays eggs in the young new acorns from the preceding year's flowers, which are present on the trees at the time of emergence of the

* This weevil was reported by Mr. B. O. Coventry, F.C.H., and the notes given here on its life-history are from observations made by him. See *Indian forester*, Vol. XXVIII. No. 10.

insect, and that a second generation of the weevil appears in the autumn. This may prove to be the case, since the acorns ripen between August and October but remain on the tree through the ensuing winter. The pupal stage in the spring only lasts a few days.

The eggs are evidently laid on the acorns, the weevil not improbably drilling a hole into the fruit with its proboscis and placing them in it. As many as six or seven beetles have been obtained from one nut. The larvæ feed inside reducing the kernel to a powdery mass, no external opening being visible in the outer skin of the fruit. Mr. Coventry thus describes the pupation :—" On removing this shell or skin the pupæ are seen lying each in a separate compartment of its own. The kernel of the acorn, though reduced to a fine powdery condition, is still firm and fills the shell so that when this latter is removed the inside appears solid, with the pupæ lying in little compartments on its surface (see fig. 5*c*) With slight pressure, however, it falls to pieces, and it is seen that each compartment is really a small cradle-like cocoon covered above by the shell of the acorn." When ready to emerge a hole is bored through the shell to the outside—and this, presumably, by the first mature beetle since all the others issue by the same exit-hole. The acorns fall to the ground during the attack about the time the larvæ become full-fed. The beetle is said to be very lively, but feigns death when disturbed.

Locality from where reported.

Mr. Coventry found this weevil at, Mussoorie, in the North-West Himalayas, in June 1902.

Relations to the Forest.

This beetle is a most serious pest to the acorns of the *ban* oak (*Quercus incana*) in which it lays its eggs, the larvæ burrowing and feeding in and destroying the fruits. Mr. Coventry states that the insect is largely responsible for the absence of natural reproduction of this tree from seed in the Mussoorie Hills. He writes as follows on this subject :—" On 11th June 1902 I collected a large number of acorns of *Q. incana* at Mussoorie with the object of ascertaining what proportion of them was

sound, as I could not account for the general absence of natural regeneration from seed of this species. The result of the investigation showed that about 80 per cent. were unsound. Some of the acorns were collected from trees and others from the ground, where they had quite recently fallen. The unsoundness of the acorns was found to be due to the attack of a weevil beetle."

Protection and Remedies.

The best protective measure to take for pests of this nature is to collect and burn, when at all feasible, the whole seed crop during a bad attack, as recommended on pages 160-161 of No. 2 of these notes in the case of the *Quercus semicarpifolia* attacked by the fly *Callirhytis semicarpifoliæ*. If this were done in patches of forest only it would have the effect of greatly diminishing the numbers of the weevils on those areas, and the next crop of acorns would thus be attacked by a very much smaller number of beetles. Children could be put on at small cost to do the collection work over certain areas, and this work should be begun as soon as the acorns begin to drop.

Points in the life-history requiring further observation.

1. Do the June beetles immediately lay eggs in the young acorns to be found on the oak trees at the time they mature and emerge?
2. If this is the case, is a second generation of the insect gone through by the autumn?
3. If mature beetles issue in the autumn, do they pass through the winter in this stage or do they at once lay eggs in the ripe acorns to be found on the trees at this period of the year? If eggs are laid, is the winter passed through in the egg stage or do grubs emerge and spend the winter feeding inside the acorns?
4. The length of time spent in the grub and beetle stages.
5. The number of generations in the year.

SPHÆROTRYPES SIWALIKENSIS, n. sp.

THE SAL-BARK-BORER.

Plate XXIII, figs. 1, 1*a*, 1*b*, 1*c*.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family Hylesini.

Tree attacked:—(*Shorea robusta*) Sal.

Description.

Larva.—White curved, legless, thick, robust and much corrugated, with a small brownish yellow head; very convex dorsally, flat ventrally and elliptical in section (see fig. 1, *a*).

Pupa.—Almost spherical in shape, white, has the appearance of beetle but is soft, and legs and antennæ and wings are compressed against the sides and breast.

Beetle.—Elongate, globular, very convex above. Black, with often a reddish tinge on the thorax and basal portion of elytra. Head black, with black prominent eyes; antennæ yellow, angled, ending in a club; thorax with anterior margin half the width of the posterior, the margin produced forward into a lobe in the middle, with a transverse depression below it; sides rounded, posterior margin produced backward medianly into a sharp point, a fine raised longitudinal black line down centre, the rest of surface being covered with slightly raised irregular elevations. Elytra longitudinally striate with the intervals consisting of rows of prominent rounded serrate elevations, like blunt teeth; the elytra taper slightly towards apex, the basal margin being angularly convex and serrate; the basal fifth is often red in colour and much less deeply striate, and the elevations are less prominent than on the rest of surface. Under-surface black, the abdominal segments thickly clothed with longish yellow hair. Legs brown, tibiæ serrate on edge, tarsi lighter coloured. Length $\frac{1}{7}$th to $\frac{1}{5}$th inch. The black elevate line down prothorax, and the remarkably deeply striate and corrugate elytra serve to distinguish this insect, a dorsal and side view of which is shown in Pl. XXIII, figs. 1*a*, 1*b*.

Life-History.

This beetle makes its first appearance in the year about the middle of March in dry warm years, the beginning of April probably in cold wet ones. It is gregarious, flying to and attacking trees in swarms. The ♀ beetle, having paired with the male, bores horizontally through the bark till she reaches the cambium layer and then mines out a short gallery, which grooves both bast and wood, parallel to the long axis of the tree. In this she lays her eggs in little indentations made on either side all the way up. The larvæ on hatching out bore away from the mother gallery at angles which deviate more and more from the right angle the nearer they approach to the extremities of the tunnel (see fig. 1). On becoming full-fed the larva, whose gallery is eaten out in both bark and wood, enlarges the end of its tunnel into a kind of chamber and pupates in this. The beetles on maturing leave the pupal chamber and the tree by boring a straight horizontal tunnel through the bark. Length of egg gallery = $\frac{7}{8}$ to $1\frac{1}{8}$ inch. Length of larval tunnel is roughly about an inch. Number of eggs laid = 35-40. The plan of the egg and larval galleries is always constant and remains in the bark and sapwood of attacked trees, forming a record of the beetles' presence in the past in that forest. Fig. 1c, depicts the inner side of a piece of Sal bark showing the plan of one whole set of galleries complete and portions of two others.

The ♀ beetle remains alive for some time after egg-laying and keeps her entrance tunnel and egg-gallery completely free of all wood-dust and dirt. She finally dies in the entrance tunnel a little distance down from its mouth. The eggs laid by the March beetle are those of the first generation of the year. Larvæ hatch out within 3 to 4 days of the eggs being laid, and are full-fed about the end of April. The beetles mature some time during May, and either one or, more probably, two more generations are passed through between this and the third week in September. From this latter date up

to the beginning of May I have a complete record of the beetles' life-history. The following are notes for 1901-02 :—

On September 22nd, 1901, larvæ in the tunnels were nearly full-grown, as evidenced by the length of the larval tunnels. The mother beetles were still alive in the egg-galleries or in the entrance tunnel in bark.

Pupæ also present and one or two mature beetles.

On October 4th beetles were issuing.

On October 26th larvæ present in galleries and mature beetles. These are those of the fourth (or fifth) generation.

About the middle of November mature beetles issued.

December 16th.—Tunnels contain only full-grown larvæ, pupæ and mature beetles. These were hibernating through the winter. The pupæ in severe winters would probably get killed off.

January 18th, 1902.—Larvæ and mature beetles found hibernating in galleries.

February 25th.—Mature beetles cut out from the bark of standing, living but stag-headed Sal trees. These beetles had issued from the trees in which they had matured some time in November and then bored a short way into the thick bark of neighbouring Sal trees, and were hibernating through the winter in this position.

March 15th.—Mature beetles taken on wing. The insects had begun egg-laying. The winter and spring of 1901-02 were exceptionally dry and were thus entirely favourable to insect-life.

April 16th.—Egg galleries of ¾ to 1 inch long with larval galleries of 1-1¼ inch long containing young larvæ. Dead beetles in entrance holes. In many instances these galleries had evidently been made by beetles which had hibernated in the bark, as although externally the entrance hole was seen to be old and the entrance burrow also for a short way in, its continuation down into the bast was fresh as also were the egg and larval-galleries. The larvæ in these galleries were, of course, those of the first generation of the year.

Locality from where reported.

The insect is fairly plentiful in the Sal forests of the Dun plateau, N.-W. India. Elevation 2,000-2,500 feet. It was discovered by the writer in September 1901.

Relations to the Forest.

Although the range of this beetle, as far as at present reported, is limited, it is probable that it will be found widely extended throughout the Sal forests of the submontane regions of the Himalayas from West to East, and research may show it to be present in the Sal tracts of other parts of the country. Its life-history, as at present observed, shows that it possesses the power of rapidly increasing in numbers owing to the practice of passing through several generations in the year. It requires fresh cambium to deposit its eggs in, and will necessarily go to green trees to find this if the supply of newly-felled or dying ones were, for any reason, to become diminished in the forest.

In order to enable me to study the life-history of the pest, whose traces were plentiful in dead bark and wood in the forests, the Divisional officer, Mr. Milward, had felled for me two large healthy living trees in August 1901. As the above record shows, by September 22nd they contained numbers of larvæ both in the bole and in the larger branches of the crown. By the time the bark was dry one of the trees was covered from top to bottom with the egg and larval-galleries of this Scolytid. The galleries were not quite so numerous on the other tree. Subsequently beetles were found attacking standing living stag-headed trees. Other trees were felled for me in the spring of the following year. Throughout my observations were greatly assisted by the Range officer.

Protection and Remedies.

All trees felled should be at once barked or, if they are left as trap trees with the bark on, they should be barked as soon as they are full of larvæ and before these have pupated and begun to issue as beetles. In leases given for the felling of Sal trees in coupes a clause should be inserted enforcing the barking of the trees as soon as felled.

In the Siwalik Sal areas there is a considerable sale of Sal posts (termed locally "tors"). These are cut during the cold weather months and should be all taken out of the forest by the end of March. Provided this proviso is strictly adhered to there will be little chance of these posts assisting in the multiplication of the beetle. The tors will not be attacked if stacked in the sun two or three miles or even less from the forest, as the beetle will not lay in rapidly drying bark which would not provide sustenance for the larvæ when they had hatched out from the eggs.

There can be little doubt that this beetle may prove a source of serious danger to coppice coupes if it once becomes numerous in adjacent areas of high forest undergoing improvement by the removal of all stag-headed and sickly trees. As the older areas became cleaner the issuing swarms of bark-borers would be forced to attack the green trees. It is more than probable that coppice areas would be chosen. The attack would be certain to begin in patches, the insect working outwards from a centre. If patches of trees in coppice or pole forest appear to be dying the bark should be carefully examined. If covered with small shot holes on the outside, especially beneath the projecting edges of flakes and in crevices, portions should be stripped off and examined on the inside. If, as will be the case when the beetle is numerous, the whole inner bark and sapwood are found to be riddled with galleries containing larvæ, pupæ or beetles, the whole patch affected should be cut out and the trees either barked at once and the bark burnt or, if the barking is not possible, the whole of the cut out material should be stacked and burnt. Trap trees should be left and watched.

Points in the life-history requiring further observation.

1. The exact length of time spent by the various stages of the insect in each generation. Is this about six weeks in the case of the summer generations?
2. The number of generations in the year. Are the following periods approximately correct:—

1st generation.—Middle of March to middle or end of May?

2nd generation.—June to middle of July.?

3rd generation.—Middle of July to end of August?

4th generation.—September to middle of October?

5th generation.—Middle of October to end of November?

(This latter would probably be only a partial generation, the greater number of larvæ hibernating as such or as pupæ and only a few beetles maturing and hibernating in holes in the thick bark of other trees.)

3. Does the insect attack other trees besides the sal?

4. Does the beetle attack the sal in the Central Provinces, Chota Nagpur, N. Madras (Ganjam), N.-E. Bengal (Eastern sub-montane Himalayan forests, Jalpaiguri, Buxar-Duars) and Assam?

SPHÆROTRYPES COIMBATORENSIS, n. sp.

Plate XXIII, figs. 2, 2*a*, 2*b*.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Hylesini.

Tree attacked :—*Anogeissus latifolia*.

Description.

Larva.—When first hatched the larvæ are minute little white legless grubs, very convex dorsally and slightly so on their under surface. Pl. XXIII, fig. 2, shows a partially grown larva of this beetle.

Beetle.—Small, black, globular, constricted behind. Head black with a depression below, forehead; antennæ yellow with an elongate club consisting of several divisions. Thorax narrower in front than behind, the greatest width ⅔rds down; anterior margin with a transverse prominent depression below it; posterior produced backwards medianly into an elongate point; surface covered with minute elevations and a few sparse short yellow bristles and a longitudinal median elevate line, often not very prominent. Elytra with basal margins convexly rounded and minutely serrate, constricted behind with apex angled; they leave uncovered the last segment of abdomen; broadly striate, the interstrial portions set with small sharp elevations, much smaller than in *P. siwalikensis*; the striæ and elevations less well defined on the basal edge of elytra, the striæ curved backwards to meet in apical margin. Under-surface slightly convex, black; abdominal segments set with short sparse whitish bristles. Legs black, tarsi yellowish. Length ⅛-⅛th inch. The differently shaped and relatively larger (in proportion to the elytra) thorax and the distinctly different appearance of the striæ and elevations on the elytra serve to easily distinguish this insect from *P. siwalikensis*. Plate XXIII, figs. 2*a*, 2*b*, show a dorsal and side view of this beetle.

Life-History.

This insect lays its eggs in the cambium layer of trees. To enter the tree a circular hole is bored through the bark

and a short horizontal tunnel carried down to the cambium. This is made by one beetle only, whether by the female or male has yet to be observed. On reaching the bast a short gallery about ¼th inch long, with parallel sides, is grooved out and in this two beetles, a male and female, are always to be found: and this is probably the pairing chamber. After pairing the male leaves the chamber by the hole of entrance and the female commences boring her egg-gallery. This is straight and is merely a continuation of the pairing chamber, and is always parallel to the longitudinal axis of the tree. Small recesses are eaten out on either side close together all up this gallery, and an egg laid in each. The first eggs hatch out before the female has completed her gallery and egg-laying, so the egg stage is evidently a short one—lasting but a few days at most. The female blocks up each recess with saw-dust after laying an egg in it, perhaps to provide a first meal for the young newly-hatched larva. The egg-gallery is kept quite free of saw-dust. An examination of old galleries showed that the larvæ bore away from the egg-gallery in a radiating manner, the pattern formed by their collective galleries approaching an ellipse. When full-fed the larvæ enlarge the end of their galleries and pupate in these chambers. When mature the beetle bores its way straight out of the tree by a hole through the bark. The length of the egg-gallery is ⅝th inch to 2 inches with a breadth of ¼th inch or less. Length of larval galleries ⅓rd to 1¼th inch. Breadth ⅛th at top and $\frac{1}{16}$th inch at base, where they take off from egg-gallery. The number of eggs laid by the beetle averages 24. The plan of the gallery is very like that of *P. siwalikensis* shown in fig. 1*c*.

I consider it probable that there are at least three generations of this beetle in the year—and perhaps four. Some green *Anogeissus* poles felled in April and left lying in the forest were examined on August 6th. They were found to have been attacked from top to bottom by this beetle since they had been felled. The insects had laid their eggs in the felled poles, the larvæ had hatched out, become full-fed, pupated, and emerged as beetles. All this was plainly decipherable, but the examination showed that, whilst the work was so recent as

to have been evidently done during the year, it was not fresh enough to have been that of the beetles then swarming in the forest. The exit holes made by the beetles had had time to dry and shrivel round their edges, and the boring was no longer fresh and clean. I consider it probable that the poles had been attacked in April, soon after being felled, and eggs laid in them. The beetles maturing from these eggs probably issued some time in June and at once laid eggs in other trees, the poles in which they themselves had matured having become too dry to afford food of the nature required by the larvæ. These would be the eggs of the second generation, and beetles from them would appear in August. This theory was entirely supported by the writer finding beetles and larvæ in some newly-felled poles on the 6th of that month. The insects had settled upon these poles, which were unbarked, in a swarm and the bark was pitted with their entrance holes. Beneath they were to be found in various stages of egg-laying. In some cases but one beetle was present, having just bored down to the cambium layer. In others two were to be found in the chamber, whilst in others again the egg-gallery had been commenced, or in some cases partially completed, the eggs first laid (at the bottom end) having already hatched out. These beetles were evidently not those of the generation which had attacked the April poles, since they had obviously but just left the tree in which they had matured, and we have seen that the exit holes in the April poles had dried-up edges. I therefore conclude that they belonged to an intermediate generation, probably the second of the year, and were laying the eggs of a third.

The beetles evidently leave the trees together when mature and fly off in a swarm in search of trees in a suitable condition for egg-laying.

Locality from where reported.

This insect was discovered by the writer in the North Coimbatore Hill Forests in the Madras Presidency. Elevation about 1800 feet.

Relations to the Fores

As far as observations have been at present carried, it would appear that this beetle is capable of making itself felt as a

serious pest in the forest. It has evidently the power of swarming in considerable numbers and requires fresh bark in which to lay its eggs. At present it has only been found in newly-felled poles; but it is more than probable that it would attack young growing saplings, especially sickly ones, were the former not available. Poles inspected, which had been attacked by the insect and from which the beetles on maturing had left, were found to have their bast layer completely riddled by the pest, whilst the bark externally showed, in addition to the entrance holes, numerous elliptical rings of exit holes placed close to one another, as shown in fig. 1c. An examination showed me that this insect appears to be fairly free from parasites, as a close inspection failed to disclose any larval remains in the larval galleries and pupating chambers. In the cases where larvæ have been so attacked it is generally possible to find at least the skin of the head and perhaps a portion of the thorax and abdomen present in the pupal chamber or larval gallery. Further, the holes in the elliptical ring on the bark usually corresponded in number with the larval galleries on the inner side of the bark and in the sapwood.

Further observations are required on this point.

Previous to finding this insect the writer saw in the Coimbatore Forest Museum a portion of an *Anogeissus* post marked "attacked by insects." The post showed a series of plans of the old egg and larval galleries evidently caused by a Scolytid insect. They resemble closely the ones described here, and the post had probably been attacked in the forest by this beetle.

Protection and Remedies.

Newly-cut poles should be at once removed from the forest or barked. If neither is possible and a stream is close by they should be put into this for a couple of weeks. This will probably be sufficient to render the bark distasteful to the insects. in the case above described the trees had been cut for road-making purposes. Care should be taken to see that poles cut in excess of the requirements are not left unbarked in the forest, as was the case in this instance. The last part of April and first half of May, the last half of June and the first half of August are-

probably the flight times of the beetle, *i.e.*, the egg-laying periods, with perhaps the middle portion of September if there is a fourth, or portion of a fourth, generation.

In plantations, coppice areas, etc., all infested trees should be at once cut out and either barked, if this is possible, or burnt. The periods for treating the plantations would be the three weeks succeeding the completion of egg-laying in the different generations.

We do not yet know whether the insect attacks old trees.

Points in the life-history requiring further observation.

1. Further particulars regarding the April generation. The information about it has at present been collected from careful inspections of old attacked poles. It is fairly reliable, since there is no doubt about the time at which these poles were felled.
2. Is there a generation between the April one and the beetles found egg-laying in August? If so, the length of time spent in the various stages of egg, larva, pupa, and beetle by it.
3. The length of time spent in the various stages of the April and August generations.
4. Is there a fourth generation of the insect? If so, is it a complete one or do the larvæ hibernate as such in their galleries through the cold weather months?
5. Does the insect only attack young trees, or does it infest old ones as well? Will it attack healthy living trees if no suitable felled ones are available?

Parasitic and Predaceous Enemies of Sphærotrypes siwalikensis and S. coimbatorensis.

ICHNEUMON SP.

Plate XXIII, fig. 3.

Classification:—Order, HYMENOPTERA. Family, Ichneumonidæ.

Parasitic upon Sphærotrypes siwalikensis. (The Sal Barkborer).

Description.

Pupa.—Small slender, white, resembling to some extent the mature fly but with the antennæ, legs and wings closely pressed against the body.

Imago.—The fly is small, blackish in colour, with 2 pairs of membranous wings. The antennæ and legs are long and slender. The insect is shown in Plate XXIII, fig. 3.

Life-History.

This insect is parasitic upon the sal *Sphærotrypes*, and the dates of its autumn generation appear to coincide with those of its host, pupæ being found at the beginning of October and the imago emerging later on in the month. It is probable that this imago lays its eggs in or near the galleries containing the over wintering larvæ and that the ichneumon larva lives upon them, spending the winter as a grub. Or the winter may be passed through in the egg stage.

Locality, Relations to Forest, etc.

The insect was found in the Dun Sal areas of North-West India.

It is likely to prove, if at all abundant, a most useful insect in the forest, since it helps to keep down the numbers of the Scolytid.

The number of generations in the year and how and where each is passed through require further observation Do they coincide with those of its Scolytid host?

NIPONIUS ANDREWESI, Lewis.

Plate XXIII, figs. 4, 4a.

Reference:—Lewis, Ent. Mthly. Mag. 2nd ser., Vol. iv, p. 183 (1893).
Classification:—Order, COLEOPTERA. Family, Histeridæ.

Predaceous upon Sphærotrypes siwalikensis and S. coimbatorensis.

Description.

Larva.—Elongate pink or red with a yellowish head followed by 12 segments, the last constricted.

Beetle.—Somewhat elongate with stout mandibles; black, shining; the two exposed posterior segments of the abdomen are a deep red in colour, as are all the ventral portions of the segments and the legs. The head is rather densely punctate; the thorax about as broad as long with two large excavations, one on each side midway between the front and base, less densely punctured than head and punctures vary in size. The elytra are more evenly punctured than the thorax, the basal margin being slightly elevated, without dorsal striæ. Length 4½ millim. Plate XXIII figs. 4, 4*a*.

Life-History.

The life-history of this beetle and number of generations passed through in the year is likely to correspond to some extent to that of its hosts, the Sal and Anogeissus Scolytids.

In the Dun Sal areas pink larvæ of various sizes were present in the larval galleries of the Sal bark-borer on September 22nd, and were feeding upon the scolytid larvæ. On October 4th full-grown larvæ and white pupæ were present. Through November and on throughout the winter months pink larvæ were to be found in the galleries, and also pupæ encased in silk web coverings which I consider were those of the Niponius. These were usually in depressions eaten out in the bark. In February the hibernating places of the mature beetles were discovered. They bore into the thick bark of old trees and spend the winter here as is the habit of the Sal Scolytid. This is a most interesting discovery. In March larvæ of all sizes are present in the trees. It is possible that they do not confine themselves to the Sphærotrypes larvæ: but further observations are required on this point.

have no further observations on the life-history between April and September in the Dun areas.

In Madras, however, I found the mature beetle in the tunnels of the *Anogeissus* bark-borer in August. The scolytids were burrowing into some freshly cut poles (*vide* page 397) for egg-laying purposes, and the Niponius was present feeding upon the scolytid beetles.

In Bombay the beetle has been taken in Kanara, caught at light.

Localities from where reported.

This insect was first taken by Mr. T. R. D. Bell in Kanara, Bombay Presidency. It was subsequently found by the writer in the Dun Sal forests of Northern India and in the Talamalai Reserve in the North Coimbatore forests in Madras.

Relations to the Forest.

The life-history of this Niponius requires further study. It is likely to prove a most beneficial insect in the forest. Its distribution appears to be wide, as the above localities in which it has been taken show. It is not improbable that research will prove that it feeds upon other scolytid beetles in addition to the two species already discovered to form its food.

Points in the life-history requiring further observation.

1. Where the eggs are laid. Is it in the entrance tunnels of the bark-borers or in the egg-galleries?
2. The food of the larvæ. Do they feed upon the scolytid larvæ? I think this is practically certain.
3. The length of time passed in the egg, grub, pupa and beetle stages of this insect.
4. The number of generations passed through during the year. Does this correspond with the number passed through by its hosts? As larvæ of various sizes are to be found in the galleries they may feed upon other insects besides the host, and the generations passed through may therefore be more numerous.

CRYPHALUS INDICUS, n. sp.

THE SILVER FIR CRYPHALUS.

Plate XXII, fig. 6.

Classification:—Order, COLEOPTERA. Family, Scolytidæ; sub-Family, Tomicini.

Tree attacked:—*Abies webbiana* (The Silver Fir).

Description.

Egg.—White, oval, translucent.

Larva.—Small white, curved and legless, with a yellowish head and brown mandibles.

Beetle.—Cylindrical, black. Head hidden beneath thorax. Antennæ reddish-yellow, angled, the scape club-shaped, the funiculus 4-jointed, the first joint thick, others subequal, club oval, divided into four divisions by 3 transverse lines. Thorax not longer than broad, very convex, narrower in front than behind, the anterior three-fourths furnished with prominent acute tubercular projections set backwards, the basal portion, especially laterally, clothed with long yellow hairs. Elytra cylindrical, constricted and rounded posteriorly, very slightly wider than thorax; coarsely and irregularly rugulose and puctate and covered with a squamulose pubescence consisting of longitudinal rows of short silvery and reddish hairs. Legs reddish brown, pubescent; tibiæ curved and toothed on outer edge; with a yellow dense pubescence upon them; tarsi yellowish, first three joints equal. Length $\frac{5}{32}$nd inch. Plate XXII, fig. 6, shows this beetle.

Life-History.

The flight time of the first generation of the year of this beetle is about the middle of May at elevations of 8,000 feet. In the fourth week of the month the writer discovered it attacking and laying eggs in green silver fir branches. Either masses of eggs or young larvæ were found in the egg-chambers, the beetles having evidently been some days at work. Infested branches contained numerous beetles and appeared to die upwards from the lowest part affected.

The beetle enters the branch by boring a horizontal gallery through the bark to the bast, preferably just at or below

node though, if the nodes are already occupied, it will go in anywhere else. On reaching the bast the insect eats out in the bark and sapwood a shallow chamber in which the eggs are deposited amongst a mass of chewed wood-dust. These eggs are laid in little masses apparently stuck together on one or two sides of the chamber. In the case of Indian cryphalids it appears to be usual for the male insect to help the female in preparing this chamber; but I am not aware whether this is the case in this instance, as the attack was too far advanced when discovered. As soon as the eggs are laid the female appears to leave the chamber, going out by the hole at which she entered. The larvæ on hatching out feed upon the bast layer at the edges of the chamber, not boring definite tunnels away from it but just eating away the edges in an irregular manner.

From observations of the habits of other species it is not unlikely that there will be at least one more generation of this insect in the year, the beetles from the May larvæ probably appearing in July and ovipositing in fresh twigs and branches. This fact and the rest of the life-history of the beetle has, however, yet to be observed.

Locality from which reported.

This insect was found by the writer infesting living silver fir trees in the Jaunsar forests, North-West Himalayas. Elevation about 8,000 feet.

Relations to the Forest.

C. indicus has only been found as yet in green silver fir branches. It is probable that it always infests such. In several instances the beetles have been found killed in their entrance tunnels by an outflow of resin from the living branch. If the beetles are at all numerous the branch is often killed; and this may be the case when only a few insects infest it, since the feeding of the larvæ by continually enlarging the original egg-chamber often completely rings the branch, eating the cambium away all round. The needles on infested branches turn bright yellow and die, and thus the presence of the pest can be easily recognised at a distance. A closer examination will show on

the branches small round holes surrounded by small circular rings of resin.

It is not yet known whether this insect infests the leading shoots and branches of young saplings.

Protection and Remedies.

In ornamental plantations remove all infested branches and burn them. This should be done in the early part of June.

If young growth is affected, all trees found attacked by the pest should be promptly cut out and burnt.

Points in the life-history requiring further observation.

1. Length of time spent in the larval and pupal stage of the first generation of the year.
2. If there is a second generation where are the eggs of it laid.
3. In which stage and where does the insect pass the winter?
4. Does this Cryphalus infest young growth?

XYLEBORUS sp. prox. PERFORANS, Wollaston.

Plate XXII, fig. 7.

Reference:—Provisionally identified as Xyleborus sp. very near, if not identical with, X. perforans, Wollaston. Xyleborus perforans. Stebbing, Injur. Insects Ind. Forests, p. 65.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. sub-Family, Tomicini.

Tree attacked:— *Shorea robusta*, Gærtn. (Sal).

Description.

Beetle.—Elongate, cylindrical. Reddish. Head black, punctured with scattered projecting yellow spiny hairs; head entirely hidden by the hood-like thorax; antennæ yellowish, elbowed; funiculus 5-jointed, ending in a pyramidal club. Thorax much longer than broad, constricted and rounded in front, the hind margin almost truncate; the surface in the posterior half slightly longitudinally ridged medianly, where it is smooth and finely punctured; anteriorly set with small dense tuberculations and punctures, the tubercles merging into punctures on the sides posteriorly. Elytra cylindrical, rounded behind; finely striate with large rather scattered punctures and sparse spiny hairs; the elytra slope downwards posteriorly, the sloping portion set with sharp teeth and scattered, elongate, yellow, spiny hairs. Under-surface lightercoloured, punctate with sparse spiny yellow hairs. Legs reddishbrown; tibiæ straight, toothed on outer edges. Length $\frac{5}{32}$nd to $\frac{1}{8}$th inch. Plate XXII, fig. 8, shows this beetle.

Life-History.

This Scolytid is a dry wood-borer. It bores into the wood of the Sal tree and lays its eggs there. It usually appears to tunnel straight into the wood; but at times, after reaching a certain depth in the sap-wood the beetle turns and carries the gallery at right angles to its former direction. If the bark is still on the log this gallery may go at times through the bark in this manner instead of in the sapwood. It is carried for

about a couple of inches, and then the beetle again changes the direction and bores down to the heart-wood. The insect does not appear to require fresh bark or wood for its operations; but at the same time it is not found in very dry wood. In the latter old galleries of previous years were discoverable, but no new ones or beetles. From this it would seem to be possible that these wood-borers—and the same has been noted in several other instances—confine their attacks to a certain condition of the wood during its seasoning process. When the wood has reached a certain degree of dryness they will no longer attack it. The beetles when discovered on the 24th April were egg-laying, these eggs being in all probability those of the first generation of the year. I have no further record at present of the other stages in the life-history nor as to how many generations of the pest are passed through in the year.

Locality from where reported.

This beetle was found by the writer in the Kalesar Sal Forest of the Simla Division, Punjab, towards the end of April 1902. This piece of forest is in the plains at the foot of the Hills on the west bank of the Jumna River.

Relations to the Forest.

This *Xyleborus* is another addition to the lengthening list of the Sal wood-borers. It was found in a wood depôt attacking logs which had been felled in the cold weather of 1900-01. Further observations are required on its life-history before it will be possible to estimate the damage it is capable of committing to stores of wood.

It has been noted above that the beetle is very near, and may be identical with, *X. perforans*, Wollaston. The discovery of this insect boring into Sal wood, a wood which is spread fairly widely throughout India, is therefore of some importance. This *Xyleborus* has acquired a world-wide reputation. It has been know for over 30 years as a destructive beer-cask borer in India and occasionally causes considerable loss by riddling the staves, thus causing a leakage of the beer[1]. About 1892 it

[1] *Vide* Injus. Ins. Ind. Forests, p. 65.

appeared in connection with another industry, that of the sugar-cane in the West Indies where, under the well-known name of the "shot-borer" it has committed serious havoc. In 1900 a *Xyleborus* was reported in this connection from Bengal, and it is considered to be either identical with, or closely allied to, *X. perforans*.

Whether an insect known to be a dry wood-borer will at the same time bore into and egg-lay in living plants is a point open to very considerable doubt, and a careful examination of all the specimens so reported would appear to be required to set the matter at rest. As the writer pointed out, however, in an article on sugar-cane pests written in 1900, and published in the *Indian Museum Notes*[1], if these should on further examination prove to be identical, it will greatly aid its increase should the dry wood it affects be lying in the neighbourhood after the removal of the green crop.

Points in the life-history requiring further observation.

1. Number of eggs laid and method of feeding of the larvæ in the Sal wood and length of time spent in the larval stage.
2. Length of time spent in the pupal stage.
3. When do the beetles arising from the eggs laid in April emerge?
4. Is there more than one generation in the year? If so, how many?
5. In which stage and where does the insect hibernate in the cold weather months?

[1] Insect pests of the sugar-cane in India.—*Indian Museum Notes*, Vol. V, No. 3.

CHRAMESUS ? sp.

Plate XXII, fig. 8.

Reference :—Provisionally determined as *Chramesus* ? sp., new to the British Museum collection.

Classification :—Order, COLEOPTERA. Family, Scolytidæ.

Tree attacked :—*Quercus incana* (*Ban* oak.)

Description.

Beetle.—Small, globular, very convex above, flat beneath, widest across middle of its length. Head small, black, with a yellowish brush of hair in front; antennæ brown, angled, ending in an elongate club, having several transverse bands across it. Thorax black, pentangular in shape, anterior margin straight, slightly ridged, with a transverse depression behind the ridge; posterior margin produced backwards medianly into a point, the margin slightly elevate; surface covered with small irregular elevations. Elytra very convex, purplish or black in colour, the basal edges curving convexly inwards; striate, the basal end rough with close-set elevations, the interstrial spaces with series of fine raised points; the striæ curve inwards towards apex; surface of elytra covered with a yellowish bloom of short hair. Under-surface flat, black; five abdominal segments visible, clothed with spiny yellow hair thicker on sides than in middle. Legs black, tibiæ not toothed, tarsi brown. Length ⅛th inch.

This beetle is figured in Plate XXII, fig. 8.

Life-History.

The flight time of this beetle is about the first week in May at elevations of 6,500 ft. or thereabouts. It bores into the wood of dying or newly dead oaks for egg-laying purposes. The insect bores straight through the bark and into the sapwood and then turns to one side or the other and carries its gallery right down into the heart-wood at an angle. I have not yet found any larvæ. It is probable that these May beetles were laying the eggs of the first generation of the year. At the

beginning of July I was able to inspect a felled dead oak which had been attacked by the May beetles the preceding year. At the time of attack the tree was girdled but still alive. The July inspection failed to show any live beetles in the tree or any larvæ or pupæ, and I concluded the wood was then too dry for the insect. An inspection of old holes and tunnels showed that most of them contained a dead beetle at their mouths. From this I infer that the beetles after egg-laying and protecting the larvæ go back to the mouth of the tunnel and die there when the grubs pupate, thus effectually blocking it up against the entrance of predaceous insects. This insect probably belongs to the class of beetles known as "ambrosia" beetles, the larvæ feeding not on wood but on a kind of fungus growing in the walls of the beetle's tunnel.

Locality from where reported.

This beetle was discovered by the writer at Kathian in the Jaunsar Barwar Forests, N.-W. Himalayas.

Relations to the Forest, etc.

This insect is a wood-borer and is capable of drilling beautifully circular holes through hard oak timber. Beyond this and the fact that it flies about in swarms, when on the wing, which settle close together on *ban* oak trees and riddle the timber by closely placed galleries, little is known about its action in the forest.

Points in the life-history requiring further observation.

1. How the larvæ feed and length of time spent in this stage.
2. Length of time spent in the pupal and beetle stages.
3. Number of generations in the year.
4. Is the insect abundant?

CROSSOTARSUS CONIFERÆ, n. sp.

Plate XXIV, fig. 1.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Platypini.

Tree attacked:—*Cedrus deodara*, Deodar.

Description.

Beetle.—Long, narrow. Head and prothorax black. Head shining, with a few large punctures on it dorsally. Antennæ brown with a dark brown club almost black on the upper edge. Thorax covered with close wavy transverse striations with a few punctures posteriorly; a median line in basal half. Elytra dark brown, deeply striate each ending on outside in a curved hook-like process and bearing long yellow hairs at their apices. Ventral surface shining; thorax and head light yellow brown with light yellow hairs at the sides and scattered over the surface. Five abdominal segments visible black in colour with yellow scattered hairs. Legs yellowish-brown; front coxæ large, middle ones round and smaller, hind ones large; all set with longish yellow hairs; 1st joint of posterior tarsus compressed and set with a single row of spiny hairs. Length 4·7 millim. See pt. XXIV, fig. 1.

Life-History.

The mature beetle is to be found boring into fresh deodar wood towards the end of June at elevations of about 7,000 feet. It bores down through the bark either straight or at an angle until it reaches the outer sapwood and then goes horizontally down into this for some distance, the tunnel curving towards its lower end where the eggs are laid. As yet it has only been found in fresh newly-felled deodar trees whose bark is still full of sap. In these the beetle burrows into the wood indiscriminately both at the thickest end of the tree (where the diameter was 3 feet across) and equally into the top and larger branches. The burrows made are cylindrical. I have not yet found the larvæ, and do not know whether the beetle frequents dry wood. The insect has the curious habit of moving up and down its tunnel, it being often found in the portion of the tunnel in the bar..

The insect belongs to the "ambrosia" bettles, *i.e.*, its grubs probably feed upon a fungus growth in the tunnel, made or induced and controlled by the parent, and this movement of the latter up and down the tunnel may be in connection with the development of this peculiar growth. Whilst in its boring the beetle's movements are active enough when outside, owing to its long weak tarsi, its walking powers are feeble.

Locality from where obtained.

This beetle was discovered by the writer in newly-felled deodar trees in the Tehri Garhwal forests of the North-West Himalayas.

Relations to the Forest.

This insect is a wood-borer. It has at present only been found attacking trees still having their bark on, this latter being quite fresh and full of sap. The insects riddle the wood by boring cylindrical holes down into it for egg-laying purposes.

We require to know more about its life-history before its exact importance in the forest can be stated. The insects would appear to have the power of swarming in considerable numbers.

Protection and Remedies.

Until further observations on its life-history are made, and the point settled as to whether it will attack unbarked wood, no definite proposals can be made under this head.

Points in the life-history requiring further observations.

1. Are the June beetles those of the first generation of the year, or do they lay the eggs of the first generation of the year, having themselves hibernated through the winter?
2. The number of eggs laid by the beetle.
3. Where and on what the larva feeds and length of time spent in this stage.
4. Length of time spent in the pupal stage.
5. The number of generations in the year.
6. Does the beetle only attack newly-felled unbarked trees, with the bark still on, or does it also infest dry barked wood?

CROSSOTARSUS PICEÆ, n. sp.

Plate XXIV, figs. 2, 2*a*.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Platypini.

Tree attacked:—*Picea Morinda*, Spruce.

Description.

Resembles last to some extent but differs in the thorax being shorter with no median line. In the female the head is large with a transverse median line and two longitudinal depressions behind it on vertex. The elytra are broad, slightly wider in front than behind terminating at apex in two processes which curve over to almost meet the centre portions of the apices. The abdomen is concave. In the male the head is smaller, the transverse line being absent; the elytra are narrower and parallel, the terminal hooks being shorter and only slightly curved inwards, and the body is not concave. Length 4·6 millim. Fig. 2 shows the female and fig. 3*a* the male of this beetle.

Life-History.

This insect bores into the wood of spruce. A number of dead insects were found in tunnels in the wood of a large dead girdled spruce, the tunnels having been bored above the girdle. I am at present unaware whether the insect bores into the wood whilst still fresh or only after it dies. This is all the information at present known about this beetle. The insect was taken in Tehri Garhwal, North-West Himalayas.

DIAPUS IMPRESSUS, Janson.

References :—Jan. Ind. Mus. Notes III. 1. 74. Stebbing. Injur. Ins. Ind. For. p. 62.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Platypini.

Tree attacked—*Quercus incana*, (*Ban* oak).

Description.

Larva.—White, legless, with a light orange-yellow head and black mandibles. It differs from a Scolytid larva in being almost straight instead of curved.

Beetle.—An elongate narrowish insect with long weak tarsi. Red-brown, shining, basal margin of the thorax and elytra brownish yellow, apical portion of the latter red-brown, legs and antennæ pale yellow; the knees brownish. Head vertical, a little broader than thorax, dull, sparsely punctured. Antennæ with the scape broadly pyriform. Thorax oblong, strongly emarginate at the sides before the middle, the basal margin bi-sinuous, a row of hirsute punctures close to the anterior margin, the base finely and closely punctured and with a slight median line. Elytra punctate-striate, the second stria from the suture and the outer marginal one broader and more strongly punctured, the first and second interstices from the suture strongly raised, the fourth slightly convex; the apex coarsely punctured, sub-truncate and unarmed in the male, in the female with five acute apical spines. Under-surface light orange-yellow between the second and third pair of legs, brown anteriorly to this, and dark-brown to black on abdominal segments which are very short. Abdomen densely pubescent at the apex in the male, in the female concave and rugulose. Anterior tibiæ crenulate on the outer side, the tarsi very slender and longer than the femora and tibiæ together. Posterior tibiæ triangular, the first joint of the tarsi rather longer than the tibiæ, broad, flattened, and ciliate, the remaining joint slender and together about half the length of the first.

Life-History.

Specimens of this beetle were taken as long ago as 1891 at Deoban, Jaunsar, where they were found boring into oak stumps. Nothing further has been heard of this beetle, nor does it appear to have been ever taken since.

DIAPUS sp. prox. IMPRESSUS.

Plate XXIV, figs. 3, 3*a*.

Classification :—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Platypini.

Tree attacked :—*Quercus incana*.

Beetle.—This beetle resembles D. impressus but is much larger, being 5-5·4 millim. in length. The colour is darker red, the thorax being entirely of this colour as are the legs, with the exception of the tarsi which are lighter brown. The front of the head is only very finely pitted in the male but strongly punctured in the female. The thorax is strongly constricted at the sides behind the middle and has no median line. The apical margin of elytra is concave in male and in female truncate, with the outer edges produced into teeth curving inwards. The abdomen is concave behind in the female. Figs. 3, 3*a* show the male and female of this insect.

Life-History.

This insect is to be found on the wing at the commencement of June at elevations of about 6,000 feet. At that period it tunnels into the wood of oak trees for egg-laying purposes. The beetle appears to choose trees the wood of which is nearly or quite dry, and bores down into the heart-wood through the thickest bark. Externally their presence can be recognised by the rings of sawdust surrounding the circular entrance hole. The tunnels are either quite straight or may be slightly curved: but, as far as present observations go, they do not appear to branch at all. Both beetles and larvæ were discovered at the bottom of the tunnels, no offset borings having been made to lay the eggs in. As in the case of the Deodar Crossotarsus the beetles appear to live for some time after laying their eggs, and are to be found moving up and down the tunnel the head pointing inwards. As in the case of this latter insect this Diapus is an ambrosia beetle. The sides of the tunnel throughout are discoloured by a fungus growth upon which the grubs were apparently feeding. The beetles appear to finally

die near the entrance of the tunnels. The galleries are at times as much as 9-12 inches in length.

I have no further observations on the life-history of this insect at present, and do not know whether it has more than one generation in the year.

Locality from where reported.

This insect would appear to be fairly abundant in the oak forests of the Jaunsar Division, in the North-West Himalayas.

Relations to the Forest.

This *Diapus* is a wood-borer and, as far as is at present known, prefers wood which is nearly dry. It bores into felled and girdled trees and also into oak stumps, laying its eggs in the heart-wood. A curious point about the tunnel in the *ban* oaks is that a section always shows a little circular black line surrounding the hole and at a distance of about $\frac{1}{32}$nd inch from the opening. This goes right down through the wood forming, so to speak, a small black cylindrical rim surrounding the hole. This ring has probably some connection with the fungus growth induced by the beetles. A large tree which had been girdled some years before, but which was not dead in 1901, was felled in that year (in May). It was found badly riddled by the beetles in June 1902. They had bored in on all sides, as much in the upper side of the tree where the bark was exposed to strong sunlight as lower down the sides which were in shade.

Protection and Remedies.

Trees of which the timber is required should not be girdled and allowed to stand in the forest after death. Fallen logs and firewood stacks should be removed as soon as possible.

Points in the life-history requiring further observation.

1. Does this beetle attack freshly-felled timber or does it require dry or nearly dry wood?
2. The number of generations in the year. Do the June beetles lay the eggs of the first generation of the year (if more than one)?
3. Length of time spent by the larvæ in the tunnel.

4. Length of time spent in the pupal stage.
5. Length of time spent in the beetle stage. How long does the beetle live after egg-laying?
6. In which stage is the winter passed through? Do the beetles which were found in June hibernate as such through the winter?

DIAPUS TALURÆ, n. sp.

Plate XXIV, figs. 4, 4*a*, 4*b*.

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family Platypini.

Tree attacked :—*Shorea Talura*.

Description.

Egg.—Very small, in shape like a hen's egg, translucent and colourless, shining. Length ·4 millim.

Larva.—Not full grown. White, legless, elongate and not curved. Length $\frac{1}{16}$th inch in largest specimens obtained. Fairly active.

Beetle.—Elongate, narrow, shining. Head and thorax dark chestnut-brown, almost black; basal margin, sides and apical portion of elytra chestnut-brown, rest pale yellow. Antennæ yellowish-brown, legs pale yellow. Head vertical, broader than thorax, shining and glabrous; eye vertical, pale silvery yellow. Antennæ set with long curved yellow hairs on scape and funiculus, scape subcylindrical, longer than funiculus. Thorax oblong with shallow depressions on anterior half, emarginate at sides before middle, basal margin bi-sinuous, finely pitted with a median line. Scutellum is large, triangular and separates the elytra at the base. Elytra smooth, finely punctate-striate, their apices produced into points in the female, concave in male. Last abdominal segment pubescent. The thighs of the middle pair of legs fit into sockets on the mesosternum. Length $\frac{1}{8}$th inch. Figs. 4, 4*a*, 4*b*, show the larva and male and female beetles.

Life-History.

This beetle is to be found on the wing at the beginning of August in Southern India and lays its eggs in wood at this period. On the 6th August beetles' eggs and newly-hatched larvæ were discovered in the wood of *Shorea talura*. The beetles bore circular tunnels right down into the heart-wood of the *Shorea*. From the lower part of these tunnels small off-shoot galleries at right angles to the main one are cut out and the eggs laid in these. The main tunnel appears to

be invariably bored right down into the heart-wood and, in the case of a felled tree, is bored vertically downwards through bark and sapwood. The larvæ are "ambrosia"-feeders feeding upon a kind of fungus growing on the walls of the parent beetle's tunnel.

Locality from where reported.

This insect was discovered in the North Coimbatore Forests of the Madras Presidency.

Relations to the Forest.

This beetle bores into comparatively fresh *Shorea talura* wood. The tree which it was found attacking had been felled in the preceding April for road repair work. Until more is known about its life-history its importance in the forest cannot be determined.

Protection and Remedies. Points in the life-history, etc.

These are much the same as already given for the Deodar Crossotarsus above. We require to know whether the insect infests dry timber and whether it exists in any abundance in the forest.

DIAPUS (?) HERITIERÆ, n. sp.

Plate XXIV, fig. 5.

Reference:—Provisionally named as *Diapus ? heritierc.*

Classification:—Order, COLEOPTERA. Family, Scolytidæ. Sub-Family, Platypini.

Tree attacked:—*Heritiera littoralis*, Sundri.

Description.

Beetle.—Elongate, narrow, shining. Head dark chestnut-brown or black; thorax chestnut-brown; elytra pale yellow, slightly tinged with chestnut on basal margin and merging into pale chestnut-brown in upper third, becoming chestnut-brown in apical fourth. Antennæ yellow, legs chestnut-brown. Head vertical, not broader than thorax, rugose, with scattered spiny yellow hairs on front. Thorax about a quarter as long again as wide, only slightly emarginate at sides below middle, anterior margin straight; glabrous, and finely punctate. Elytra striate-punctate; 4 striæ prominent at base, the outer marginal one most prominent, the second from suture becoming less marked soon after leaving base, the first interstice from suture raised, the fourth strongly raised and convex, with scattered large punctures; a depression between second and third striæ depressed at base; apex truncate, showing 8 well-defined ridges, the depressed portion in ♀ set with 5 teeth on side and 4 apical ones of which the outermost is prolonged and turned outwards; ♂ unarmed; the truncate portion and marginal edges of elytra set with yellow spiny hairs, denser apically. Under-surface brown, abdominal segments dark-brown to black, and are very short; concave and rugulose in ♀. Anterior tibiæ toothed on outer edge. Length ♂ 4·7 millim., ♀ 3·9 millim. Fig. 5 shows the male of this insect.

Life-History.

This insect was first found by Ranger B. C. Sen Gupta, tunnelling into sundri (*Heritiera littoralis*) wood in June 1902. An examination of some pieces of attacked timber showed that the insect bored right down into the heart-wood, the gallery made by the beetle being quite straight. The following year

the Ranger was able to make some further observations on its habits in the beginning of April. The following is a summary of his valuable investigations. He found two beetles of different sizes in the pieces of wood (probably ♂ and ♀). His study of the habits led him to conclude that the adults bore through the wood into the sapwood and lay their eggs. They probably do not go into the heart-wood at this stage as he found that in all the newly attacked wood the heart-wood was left untouched; it was only after some period that the galleries were found in the heart-wood. Only a few eggs are laid in each tunnel; the number, however, has not been observed. The larvæ did not appear to bore galleries in the wood but were to be found at the bottom of the parent's tunnel. This latter may branch (or curve ?) when it has been carried right down into the wood. The larvæ pupate at the ends of the galleries and the adults on maturing make fresh borings into the timber as long as it is sufficiently fresh for their purpose. The galleries are very small, (about $\frac{1}{15}$ inch in diameter) and the adult beetles continually move up and down the tunnels. This insect is another of the so called "ambrosia" beetles, and the reason for the non-discovery of larval tunnels is due to the fact that the larvæ probably live upon a fungus growth which develops on the walls of the tunnel of the parent beetle. Since the mature insect is found in April and again in June there are evidently two generations in the year and probably several. These beetles attack *sundri* wood as soon as it has been felled, and as long as it is fresh. They will not touch dry wood. Their old galleries can be seen in this latter, but no living beetles are ever found in them. They only attack the *sundri* in this locality. Other kinds of wood, green and half dry, are left untouched.

Locality from where reported.

This insect was found by Ranger B. C. Sen Gupta at Wazirpur, in the Backerganj District in Bengal. The wood in which the beetles were found was, however, brought in boats from the Sundarbans, the latter place probably being the true habitat of the insect.

Relations to the Forest.

This *Diapus* bores into the wood of both green and half dry sundri. It infests stacks of this wood in the Sundarbans, sometimes in large numbers, and at times, according to Ranger Gupta, completely riddles and spoils the timber. The presence of the bark on the wood is immaterial, since the insect will burrow down into unbarked timber with equal ease.

Although the beetles were found in the Backerganj District it was always in timber that had been brought from the Sundarbans forests, and the beetle is probably indigenous to these forests, from which all the sundri wood comes, and is carried about in the wood when it is exported. This export is always done in boats, the latter proceeding through the various mouths of the Hoogly river and their connecting network of canals to Calcutta, and the surrounding Eastern Bengal towns and villages.

Protection and Remedies. Points in the life-history, etc.

These are much the same as already given for the deodar Crossotarsus.

In these Eastern Bengal districts it would be quite feasible to keep the green wood under water for a few months, by which means it would escape the attacks of the beetles. As soon as it had lost its sap it would no longer be palatable to the *Diapus*.

CLANIA CRAMERI, Westwood.

The Casuarina Bag-Worm.

(*Vide* No. 1, p. 56.)

Classification: Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Psychidæ.

Tree attacked:—*Casuarina equisetifolia.*

This insect is to be found in the Casuarina plantations on the East Coast of Madras.

Egg.—The eggs are laid within the larval bag by the wingless ♀.

Larva.—Full-grown. The portion of the caterpillar seen outside the case when it is feeding or walking has a mottled appearance. It is shining, hairless, yellow to yellowish-white, with black spots and markings. Head large and prominent. Front legs black and yellow, long and stout. The front segments of the body are fairly large and thick, those behind (seen when the grub is taken out of the case) smaller. The case is formed of small pieces of the needle-like leaves of the Casuarina placed side-by-side, so as to form a cylindrical bag open at both ends. The head of the case is lined with a greyish thick silken bag which protrudes. It can be closed by the larva when the latter retires into the case. The case inside is lined with a shining layer of white silk.

Just after leaving the egg.—The little grub is very small and has no case. The head is black, shining, large. Mouth-parts brown, the segment immediately following black, with a white edging. The next two segments yellow with narrow black to brown transverse bands dorsally, the band being divided in the middle on the third segment. These three segments are each furnished with a pair of legs. Rest of segments orange-yellow and are held curved up over the back. All the abdominal legs are present, but are not functional and are never placed upon the ground, the minute caterpillar walking on the front ones, these being well developed and

On visiting the plantations at Chatrapur (Ganjam) the insect was found to be very fairly numerous. It escapes general notice, as all that is usually apparent to the observer is the greyish case hanging to the branches of the trees. This, as the caterpillar the case contains is not seen actively feeding, is not associated with any defoliation the trees may have undergone. Some of the larvæ found near the middle of the month were full grown, others had pupated, whilst one moth issued in the box they were kept in on the 13th. Others were bred out in the Indian Museum on the 18th, 25th; August 4th, 12th, 13th, 14th, 19th, 20th and 24th, respectively. The pupal stage would appear to last from 10 to 14 days, but further observations are required on this point. Female moths were obtained at the Museum through August.

Before pupating the caterpillar attaches its case to the branch or twig of the tree, and then closes up the silken bag-like mouth. It then turns round in the case so as to hang head downwards and becomes canary-yellow in colour, entirely losing its mottled appearance: its head and first segments also shrink greatly in size. When the male moth is ready to emerge, the pupa forces itself downwards through what was formerly the bottom or posterior part of the case until it projects about two-thirds of its length. The moth then bursts the upper end of the pupal case and emerges.

The female moth remains in the case and the male pairs with her in this position. A very large number of eggs are laid. From countings made of young larvæ which issued in the Museum I find the number of these latter issuing from eggs laid within the bag by one female to be between 550 and 600. The eggs hatch within a week of laying. The young larvæ on issuing from the egg are naked; *i.e.*, they have no bag. They are very active on leaving the old case and spread out over the tree, walking with great rapidity. In this defenceless state they must be very subject to attacks of all kinds of predaceous foes, and also be liable to be drowned during heavy rain-storms. Within 20 hours they make their first covering or bag, this being formed of a small piece of the epidermis of the bark of a twig. This is added to as they grow large.

Larvæ a week old have a double coil of this epidermis forming their case. The first larvæ issued in the Museum cages on the 6th August: others on the 15th and 26th, these all being those of the second generation of the year.

The life-history of the larvæ which issued on the 20th August was watched up to the 19th November and the following notes made. By the 1st September a very large number had died off. The remaining ones were quite healthy: they had reached the stage at which they cut off the green needle-like leaves to use in enlarging their cases. The caterpillars had by now assumed their mottled appearance, though they were still only half inch in length. They, however, naturally varied greatly in size. The needles are cut off and placed longitudinally on the case side by side. The first of these larvæ pupated about the middle of October, and the cold weather is apparently passed in this stage.

The larva is a heavy feeder and eats the needle-like leaves of the Casuarina from top downwards to the base, or it may bite through the needle (leaf) half-way down, the upper portion falling to the ground, whilst it consumes the lower; it is a most wasteful feeder.

Results of attack.

This insect when numerous would be capable of entirely defoliating a plantation and, consequently, its life-history requires to be well understood. Unless the defoliation is very heavy, the insects' attacks will probably remain unnoticed; and since the larva is very quickly alarmed (when it immediately retires within its case), even if the defoliation is noticed, it would not ordinarily be placed to the credit of the apparently small dead bundles of sticks hanging from the branches. From the large number of eggs laid by the females which are more abundant than the males, as can be readily distinguished from the fact that their cases are larger, it is evident that in a dry, warm, favourable season the mortality amongst the young larvæ would be much less, and this would undoubtedly lead to very severe, if not total, defoliation in the plantations. It is not improbable that the death of trees attacked by the

wood-boring *Arbela* caterpillar described on page 438 is accelerated by defoliation due to the larvæ of this *Psychid*, and it is of importance that its life-history should be fully worked out so that we may know how many generations it passes through in the year, *i.e.*, how many times in the year the trees run the danger of being defoliated.

Protection and Remedies.

Undoubtedly the best method of reducing the attacks of this pest is by the collection of the larval cases. Owing to the thin light foliage of the tree these cases, once they have been pointed out as the source of damage, are easily recognisable and very easily seen in the plantations. Their careful collection in years of serious infestation would well repay the expenditure incurred, and would practically stamp out the pest. The periods at which this collection should be undertaken depend upon the number of generations passed through in the year. For the June-July generations of larvæ the best time would appear to be the latter half of June, and for the October generation during December-January

Points in the life-history requiring further observation.

1. When the eggs of the first generation, *i.e.*, that producing the June-July caterpillars, are laid.
2. How long the eggs of the first generation take to hatch after they have been laid.
3. Time spent in the larval stage of the first generation.
4. The number of generations in the year. This is extremely important, as it is necessary to know how many times in the year the trees may be subject to this defoliation. Are there more than two?

DUOMITUS LEUCONOTUS, Walker.

Plate XXV, figs. *a-e.*

References:—Hampson. F. B.I. Moths, I, 308 No. 660; Stebbing, J. A. S B. LXXIII, Pt. II, 225 (1904).

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family Cossidæ,

Tree attacked:—*Cassia nodosa.*

Duomitus leuconotus is one of the wood-boring moths belonging to the family *Cossidæ*. Turning to Hampson's Moths, in Blanford's Fauna of British India, we find that but six genera of this family are at present known in India: *Cossus*, *Duomitus*, *Axygophleps*, *Eremocossus*, *Phragmatæcia* and *Zeuzera*. This paucity in the known genera of the family is carried into the described species of which a list of but twenty-five are known, the numbers per family being as follows: *Cossus* 6, *Duomitus* 6, *Axygophleps* 5, *Zeuzera* 5, *Phragmatæcia* 2 and *Eremocossus* 1. About the habits of the majority of these species little is known. It is probable that most, if not all, of the larvæ live and feed in the wood of trees, and some of them may spend several years in this manner before changing to pupæ. In most instances, however, neither the larvæ nor pupæ have yet been discovered and described. While, however, this is the rule in the family, there are two notable exceptions, in each of these cases the insects being of economic importance. *Duomitus niger*, an insect closely allied to the species we are considering in this paper, is the moth whose larva is known as the "Black-Borer" of Coffee-planters, and has proved a source of considerable loss on Coffee estates, whilst *Zeuzera coffeæ*, the moth whose larva is known as the Red-Borer (called by Hampson White-Borer),* commits great destruction in Southern India and is a pest well-known to Coffee-planters. The life-histories and habits of these two insects are more or less well known. Of the other representatives of the family in the

* The real "White Borer" is the larva of a Cerambyx beetle. *Vide* my "Note on the Sandal-wood-boring insects of Madras," published in the Appendix Series of the *Indian Forester*, Vol. XXIX, No. 7 (1903).

Indian Region we have, however, little on record save the descriptions of the moth, in some cases both the ♂ and ♀ of a species having been described, in others the description of the ♂ or the ♀ only being available. During the last few months (1903) I have had an opportunity here in Calcutta of working out a portion of the life-history of one of the other known species of Duomitus, that bearing the name of *D. leuconotus*, Walker, and my observations are recorded below.

Description. *

Neither larva nor pupa appear to have been previously described.

Larva (about half-grown).—General tint, a dark flesh-colour with brown head, yellow prothoracic segment edged in front with black, with a few black specks behind; canary-yellow mesothorax and flesh-coloured metathorax. Following eight segments are flesh-coloured, lighter at junction of segments. Last segment is canary-yellow, becoming orange-yellow at extremity. The head is dark chestnut-brown anteriorly, shining, chitinous, ovate and large; mouth parts black, antennæ short, 3-jointed, yellow-brown. Posteriorly the head shades off into pale-brown and yellow. It is followed by a large prothoracic shield which is hard and chitinous and shining, slightly convex. The chitin terminates at the sides, the under-surface of prothorax being canary-yellow in colour and soft. The large chitinous shield is ovate, anterior margin straight, posterior ovate-elliptical. At the posterior edge of the thoracic plate is an elliptical circle of small raised spikes or spade-like protruberances, doubtless used to shovel out of the way wood refuse and perhaps for scraping purposes. They are set backwards and are club-shaped. Behind these are a number of minute black spots placed in a crescent-shaped manner on the mesothorax, the angles pointing forwards. The mesothorax is much narrower and smaller and has a soft skin. The following segments are equal in size, about a third less in diameter than

* The description and life-history here given are abridged from a paper read by the Author before the Asiatic Society of Bengal and published in the Journal, Vol LXXIII, Pt. II, No. 2, p. 25, 1904.

the prothorax, and have a few scattered black tubercles on them, each bearing a thin white hair. The last segment tapers to a blunt point.

Mouth-parts pale-yellow beneath. Thorax beneath dark canary-yellow and rest of segments dark-yellow. Thoracic legs canary-yellow, pro-legs dark-yellow, flat and thick. Length 1½ inch. Plate XXV, fig. *a*.

Pupa.—Sub-cylindrical, stout. Dark chestnut-brown to almost black. Black ventrally. Segmental bands orange, as also is front of thorax. Wing covers, eyes, antennæ and legs well marked on outer covering. Stigmata black, with a circular orange edging. Nine dorsal segments plainly visible, and 5 ventral ones.

Length 2 to 2¼ inches. Size very variable. See fig. 6.

The *moth* of which descriptions of both male and female are given by Hampson in the Fauna is a large, stout, striking-looking insect with a white thorax and greyish mottled wings (see figure in plate XXV). Hampson gives the wing expanse in the ♂ as varying from 98-128 millim., that of the ♀ being given as 180 millims. The specimens obtained by me this year show that there is a very much greater variation in size in both sexes. The following dimensions of 32 moths, all taken from the same tree, are, I think, well worthy of being placed upon record:—

Expanse of wings in ♂		Expanse of wings in ♀	
80	millims.	116	millims.
110	,,	88	,,
103	,,	88	,,
90	,,	77	,,
83	,,	100	,,
78	,,	100	,,
90	,,	115	,,
95	,,	98	,,
82	,,	84	,,
73	,,	96	,,
70	,,	108	,,
85	,,	125	,,
74	,,	80	,,
99	,,	120	,,
72	,,	80	,,
70	,,	85	,,
♂ —70 to 110	,,	♀ —77 to 125	,,

The above figures show the very great variation in size to be found in both sexes.

Life-History.

The moths appear on the wing in the latter half of September, and are to be found during the remainder of that month and on up to about the third week in October. They are extremely sluggish during the daytime, but are powerful fliers at night. In the day they are to be found clinging to the bark of trees which their general colouration greatly resembles, thus serving to protect them from the attacks of enemies. The male lives but a few days and dies after pairing with the female. The latter lays her eggs, which are small, yellowish and deposited in irregular-shaped masses stuck together with some siccable material upon the bark of trees. She dies as soon as she has finished ovipositing. Examination of attacked trees has shown that these eggs are laid anywhere upon the woody parts of the tree, and that the young larvæ on hatching out bore straight through the bark to the sapw ood and feed in this for a time, subsequently going into the hard wood of the stem or branch. The mortality amongst the young larvæ must be very high, since it would be quite impossible for any one tree to support the large number of larvæ the eggs of a single moth give rise to, it being remembered that almost the whole of this stage is passed feeding in the wood. The larvæ almost certainly spends not less than two years feeding in the wood of the tree. The evidence for this assertion was found in the case of a tree which had practically been killed by the insects. Mature pupæ and moths were taken from this tree and also two half-grown (or less) larvæ. Since the moths only issue in September-October it is evident that these larvæ hatched from eggs laid at the very latest in the year before.

The larva bores in an irregular manner in the wood, the tunnel having apparently no regular or definite direction. The tunnel increases in diameter with the growth of the grub, finally measuring over half-an-inch across. It is packed with the wood sawdust and excreta of the larva. When full-grown the larva carries its tunnel to the outside, boring a hole through

the bark, and this hole will be observable on the outside owing to the fresh sawdust to be seen just below it on the bark of the tree. Having thus prepared an exit, the caterpillar backs down its tunnel for a distance of 2-3 inches (this space being kept quite free of wood particles) and spins stout web-like series of strands of a coarse yellowish-brown silk across and below the mouth, thus effectually preventing any intruder entering the tunnel from outside getting near it. The larva then pupates. These strands of coarse brown silk are very characterstic of the pupation of this *Duomitus*. The pupal stage is probably a short one—at the most from six weeks to two months. Pupæ were found fully mature and also but newly changed from larvæ early in September, but they had all issued by the end of the third week in the following month. The hole bored to the outside by the larva is more or less vertical, only inclining to the horizontal just near the bark, so that the pupa, when the moth is ready to emerge, creeps up the tunnel and projects from it at an angle at right angles to the stem of the tree. In doing this the pupa bends over at an angle, the upper half being almost horizontal, whilst the lower portion remains in the almost perpendicular tunnel (see fig. *d*). The pupal skin then splits down at its anterior end, both dorsally and ventrally as far as the posterior edge of the last thoracic segments, and the moth crawls out. In the cleavage the head and antennal covering come away as one piece.

Distribution.

This insect was taken in Calcutta in 1903; Hampson gives the distribution as Simla, Sikhim, Calcutta, Ceylon.

Relations to Forest.

It has been seen that the larvæ live in the wood of living trees, and observations have shown that they will desert trees which have been cut down and the wood of which has consequently begun to dry. On the 22nd September of this year (1903) my attention was drawn to a small *Cassia nodosa* in the Indian Museum compound, which was evidently in a dying condition, the spring crop of leaves having all dropped and no new ones having replaced them. Examination showed that the tree was infested by the larvae of this moth, several holes with half-protruding empty pupal cases being perceivable. The tree was only 15 feet high with a girth of twenty inches at the base. It was much branched all the way up and had a whippy spreading crown. I had this tree cut down and placed in a large wire-gauze cage. In addition to two half (or less) grown larvæ and some live pupæ (taken to preserve in spirits) the following moths were obtained from the stem as they issued on the dates noted. [A portion of this stem, with the empty pupal cases *in situ* protruding from the bark, is now exhibited in the Insect Pest Gallery at the Indian Museum: the other half has been sent to the British Museum (*Vide* fig. *e*.).]

Date of issue.	♂	♀
22nd September 1903	1	1
23rd " "	2	...
24th " "	...	3
25th " "	1	1
26th " "	2	...
27th " "	1	1
29th " "	4	...
30th " "	...	3
3rd October "	...	2
4th " "	2	1
8th " "	2	1
10th " "	1	2
16th " "	...	1
TOTAL	16	16=32 moths.

In addition to these 32 moths there were two others which never acquired their proper wings, on issuing, probably due to the handling the chrysalids received. It is probable that at least 40 moths left this tree during September and October.

In addition to the small *Cassia nodosa* tree, which may be said to have been killed by this insect during 1903, a much larger tree, some 35 feet high and 3 feet in girth, has been attacked, more especially at its base, as evidenced by several empty pupal cases protruding from the bark surface.

Protection.

The moth was noticed in various parts of Calcutta during the above-mentioned weeks, and was evidently this year fairly abundant. We have yet to discover what other trees it infests in addition to the *Cassia nodosa* which Major Prain, who very kindly identified the tree for me, tells me was originally sent to the Museum from the Royal Botanic Gardens at Sibpur.

Points in the life-history requiring further observation.

1. Length of time spent in the larval stage.
2. Number of eggs laid by the female insect.
3. The different species of trees infested.

ZEUZERA COFFEÆ, Neitner.

THE RED BORER.

Reference:—Nietn. Edin. New Phil. Journ. XV, 1862, p. 36; C. & S. No. 1568; Moore, Lep. Ceyl. ii, pl. 143, figs. 1, 1a, b (larva) Steb. Injur. Ins. Ind. Forest, p. 104, fig. 168.
Zeuzera oblita, Swinh. Trans. Ent. Soc. 1890, p. 19
Zeuzera roricyanea, Wlk. Journ. Linn. Soc., vi, p. 177 (1862).

Classification:—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Cossidæ.

Tree attacked:—*Santalum album*.—The Sandal.

This is the well-known red borer of the Madras Coffee districts and has always been supposed to be the chief sandal-wood-borer. I give the following description of the larva made from fresh living specimens:—

Large, stout, flesh-coloured to darkish red. Prothorax smaller and hood-like, yellowish with thin black blotches placed triangularly upon it. Mouth-parts black. Dorsal surface of last segment dark coloured. This segment is smaller than the others and tapers bluntly. Larva is lighter coloured below.

Life-History.

This has been already described in *Injurious Insects* (p. 104), and I need not recapitulate here. It may, however, be mentioned that the moths appear on the wing in February and the eggs are probably laid somewhere about this time.

Results of Attack.—The eggs are laid upon the bark of the branches or upon that of young saplings, and the boring caterpillar confines itself to these parts. It requires soft woody tissue for its food and does not bore into the hard heart-wood of older trees, as is the case with the *Stromatium* beetle (see p. 379 *supra*). It is a serious pest to young saplings, as these are either killed outright under its operations or are so weakened as to be thrown down by the wind. In boring the caterpillar hollows out a large portion of the interior of the branch and keeps the tunnel quite free from wood particles and excreta. Its work is thus

unlike the longicorn borer. The difference between the work of the two grubs is most marked.

The red borer attacks and kills young saplings. If the trees get safely through this period of their life they will not be much harmed by it subsequently, as it will confine itself to attacking the branches only.

The white borer probably only kills the tree when present in numbers. It, however, invariably bores in the heart-wood, and thus spoils its quality and reduces its value.

In addition to the actual amount of injury these borers are capable of doing *per se* to the sandal, a further damage arises from the fact that the external holes form convenient methods of entrance to the interior of the tree for fungous spores and, consequently, serious fungoid attacks may follow the insect ones.

Distribution.

North Coimbatore Sandal-wood areas and, perhaps, throughout Mysore and Coorg.

Protection and Remedies.

In the case of the red borer undoubtedly the most effective check will be to cut out all infested saplings.

The operations of this caterpillar are easily recognisable from the outside owing to the fact that it keeps its burrow quite free of all wood particles, excrement, etc., and therefore small heaps of saw-dust like excrement are to be found at the foot of the tree and beneath the entrance-hole and air-holes. There will also usually be exudations of sap trickling down the bark from these holes. When these exudations are seen to be fresh and wet and when the saw-dust at the foot is fresh the borer will be found inside. Such infested trees need not be cut down at once as other moths may lay their eggs in them (it is often noticeable that for some reason or another a particular tree or trees are more favoured in this way). A careful watch must, however, be kept over them, and when the boring inside appears to have ceased the tree should be cut down chopped up and the borers or their pupæ killed. This should be

done carefully. If a number of young plants are cut out for borers they should be stacked and burnt in one heap and not be cut up at all. Every part should, however, be thoroughly burned. This remedy should be vigorously put into force when bad attacks similar to that of 1891 in Mysore have to be coped with.

Points in the life-history requiring further observation.

1. The length of time spent in the larval stage. Is it under or over a year? I found some apparently nearly, if not quite, full-grown larvæ in the first week in August. These were brought to me as the sandal pest.
2. The period of emergence of the moth. Mr. Green has stated that in Ceylon the moth does not appear to issue at any one particular period of the year. A moth was bred out in the Indian Museum, Calcutta, on the 9th February.
3. What predaceous and parasitic insects prey upon this borer?

ARBELA TETRAONIS, Moore.

THE CASUARINA BARK-EATING CATERPILLAR.

Plate XXVI.

References:—Moore, P. Z. S. 1879, p. 411, pl. 34, fig. 3; C. & S. No. 1605, Hmpsn., Faun. Br. Ind. Moths, I, 315. No. 675.

Classification:—Order, LEPIDOPTERA. Sub-Order HETEROCERA. Family, Arbelidæ.

Tree attacked:—*Casuarina equisetifolia*: The Casuarina.

This is the insect whose caterpillar forms the well-known winding covered-way galleries on the outside of the bark of the stem and branches of Casuarina trees.

Larva.—Head black, with a few longish yellowish-white hairs on it. Following three segments, which each bears a pair of long legs, yellowish, this colour merging into pink on the third These three segments are swollen and larger than the head. The following segments are flesh-coloured except the last, which is yellowish. Five pairs of short sucker legs are present, one pair each on the sixth to ninth and a pair on the last segment. A few long scattered whitish hairs on each of the segments. These nine segments are narrower than the first three and taper off slightly behind, so that the twelfth segment has only about half the diameter of the fourth. Length one and-a-half inch. Width of thoracic segments $\frac{8}{16}$th inch. Plate XXVI, fig. *a*, shows the larva, side and dorsal view.

Pupa.—Yellowish-brown except in front, where it is very dark-brown to black. Shining, circular in section and of uniform thickness throughout, except for a slight swelling at the anterior (head) end which is furnished with two small spiny spikes. The wing covers are very short and reddish-brown. The last five abdominal segments have transverse circular rows of fine teeth on them, the first three segments bearing a double row on each placed close together, the last two having but a single encircling girdle situated near the

centre of the segment. The last segment is blunt at the end and furnished with small knobs and spines. Length 1 inch; breadth $\frac{3}{16}$th inch. Fig. *b* shows two views of the pupa, fig. *c* an empty pupal case.

Moth.—♂. Forewings greyish, thickly irrorated with dull brown spots which tend to form transverse bands; three large velvety brown patches, one centrally, placed a little below costa, a second near the base of wing, and the third (the largest) a little beyond it. Hind wings grey, irrorated with a few ashy-coloured patches. Head and thorax covered with long silky-brown hairs. Body greyish. Expanse of wings = 1$\frac{3}{4}$ inch. ♀ about twice the size of the ♂. Fig. *d* shows the ♂ moth.

Life-History.

The appearance of the moth on the wing is evidently variable. In the Godavari district moths have been reported as issuing during March, whereas in Ganjam a specimen was bred out by Mr. C. E. C. Fischer in 1903 as late as the 3rd July. In 1904 Mr. Fischer obtained moths between the 7th and 25th June. In Cuddalore, on the other hand, nearly mature pupæ were taken on the 1st June. From these data it appears that the moth is to be found on the wing between March and the beginning of July. I could find none at Chatrapur towards the middle of this latter month (in 1903) though numbers of the year's empty pupal cases were visible upon the trees. It is probable that the ♀ moths pair and lay eggs very soon after issuing, since the members of this family have no mouth and take no food in this stage of their existence. The eggs have not yet been found, but they are laid upon the bark of the boles and branches from a height of 2-3 feet upwards. In Chatrapur, which receives the South-West monsoon, the larvæ hatch out at the end of August and during September, but further south down the coast, where the rain comes in October or November, they may hatch out earlier. The present recorded months in which caterpillars have been obtained are from September to May in Chatrapur (with pupa in May-June and moths in June-July); December in North Arcot (with pupa in June); the same month in Godavari (with pupa and moth in March);

full-grown caterpillars and almost mature pupæ on the 1st June in Cuddalore, and what appear to be nearly mature caterpillars in June in Nellore.* In Chatrapur it has been ascertained that the larva passes eight months in this stage of its existence. It spends most of this time feeding upon the bark, which it eats off the tree in patches which are at times several inches wide. It does not move about the bark of the tree in the open but constructs for itself a kind of covered way, resembling a glorified termite (white ant) gallery, consisting of particles of its excrement bound together with a kind of close-woven felted silk. Externally the appearance is simply that of a mass of excrementous particles. These covered ways curl round and up or down the tree and are very conspicuous (*vide* fig. *e*), being about $\frac{1}{8}$ to $\frac{1}{2}$ inch in breadth and from 9 inches to as much as 18 inches in length. They are reddish brown to, in parts, black in colour and form raised galleries on the surface of the stem. Sometimes the gallery completely encircles the stem, the tree being then ringed; at others it is taken in a spiral manner up or down the tree. At times two or more covered ways join together, but they are more usually, except in very badly infested trees, separate. The bark beneath the gallery is always eaten, either only the upper green living tissues being consumed or the whole being removed down to the sapwood. Occasionally, as mentioned above, the bark is seen to be eaten off the tree in irregular-shaped patches on either side of the covered way. This may be done by the young larvæ living and feeding gregariously together before they construct covered ways for themselves, or the caterpillar may leave the covered way at night and eat off the bark in its vicinity.† These galleries or covered ways have a more or less uniform width throughout their entire length, and from their appearance the larva would seem to add to them at the sides so that

* Larvæ have also been reported by Mr. H. A. Latham on Casuarina in South Canara in August.

† Mr. Fischer has since shown that from the very first the larva constructs a covered way made up of particles of its own excrement and bark joined with silk.

the internal chamber remains uniform in width throughout its length. When full fed the larva bores straight into the wood of the tree, generally retiring to the middle of its covered way before commencing to bore in. From the observations I have been able to make on attacked trees I have little doubt that the caterpillar only enters the wood to pupate, and does all its feeding upon the bark. The tunnel in the wood is always straight, and does not ramify as it would do if the grub were feeding in the wood.* There is generally a raised lump on the covered way, the result of the addition of the wood excrement thrown out, marking the place where the caterpillar has gone into the wood (*vide* fig. f). It enlarges the end of its gallery and changes to the pupal state. We do not yet know the time spent in this latter stage, but Mr. Fischer considers it to be from 3-4 weeks. In my description of the pupa I have shown that it is furnished with circular rows of spines; and by means of these, when the moth is ready to emerge, it wriggles and forces itself along the tunnel and pushes itself through the mass of excrement which forms the covered way, from which it remains protruding about a quarter of its length. After the moth has left the pupal case, the empty skin of the latter may

*In an article on the "Casuarina bark-eating caterpillar (*Arbela tetraonis*)," published amongst the Scientific Papers in the *Indian Forester*, XXXI, (1905) Mr. Fischer gives the following information upon this insect from observations published since the above was written:—"The earliest date upon which the larvæ were observed was 26th August. They feed on the bark, restricting themselves to the superficial layers when very young and gradually working in deeper as they grow . . . At an early stage the larva constructs at one extremity of the covered way a small chamber under the bark, preferring to locate it in the upper angle formed by the junction of a twig with the bole. Here the grub rests when not feeding. It emerges to feed upon the bark immediately surrounding the extremity of the 'fan' which is built up further as the bark is eaten around it. It apparently feeds at night, as I have never found it by day outside the covered way, nor indeed anywhere but in the chamber described. The larva attains its full size in March or April, and then prepares the pupal chamber. Up to this stage it has penetrated the bark alone except when an existing hole has been used as a resting chamber. If such a suitable hole has been found this is probably merely trimmed, otherwise the larva . . . bores into the wood and excavates a pupal chamber about an inch in depth, and this it enters in May or June, pupating with its head towards the orifice which is concealed by the extremity of the covered way."

be seen, projecting from the covered way. Therefore, when this latter is visible, it may be taken for granted that the insect which formed the particular covered way under inspection has left it.

Results of attack.

This insect appears to be fairly wide-spread throughout the Casuarina plantations, and it has been reported to commit considerable damage in some. Information is still far from complete, but damage is undoubtedly committed in Ganjam, North Arcot, Godavari, Cuddalore and Nellore.

In feeding upon the bark the insect in its younger stages only consumes the more tender and greener portions of the outer thin bark, but as it grows older it eats right down to the sapwood and even into it, either in a continuous ring or in small irregular patches. Thus the trees are often seen to have holes and pits through the bark reaching to the wood beneath. These "weather" and at times coalesce. In the plantations I visited I noticed that some trees were much more severely infested than others, and in these the action of the caterpillars had almost ringed the trees. There can be little doubt that when thus badly attacked the trees die. Both young and old trees are equally subject to attack and the larva feeds equally upon the thicker bark at the base of the tree and the thinner near the top. The covered ways are, perhaps, shorter in the lower portion of the tree.

Towards the end of 1900 the District Forest Officer of North Arcot reported that these caterpillars had nearly ruined the Anuñuhdi Plantation. The plantation appears to be infested in patche. In the Agusti Nowgam Plantation near Chatrapur, in Ganjam, where the insect would seem to have only recently appeared (it being pointed out to the Divisional Officer by the Conservator in December 1902), the attack was confined to one patch of the area, the rest being entirely free. A private plantation, about a couple of miles away, was unattacked, whereas the Chatrapur Plantation, about 4 miles from the Agusti Nowgam one and a mile or so from the private one, was badly infested in parts. The attack doubtless spreads

outwards from these infested areas and, in course of time, infects the whole plantation.*

Summing up, therefore, we see that the damage is done entirely by the caterpillar and that, as far as present observations have shown, this latter feeds entirely on the bark, only entering the wood of the tree to change to the chrysalis state.

* It has been already stated that the writer visited Chatrapur in July 1903. In his paper previously alluded to, Mr. Fischer tells the history of the progeny of the moths whose empty pupa cases were seen so plentifully in July. It is a most remarkable instance of a somewhat rare occurrence—the swarming in large numbers of one of the wood-boring, and usually far from common, species of moths. Considering the rareness of this Arbela in collections Mr. Fischer's observations are little short of wonderful. Stating that the larvæ from the eggs laid by the June-July moths commenced to issue at the end of August, he continued :—"It soon became very obvious that this fresh attack was far more intense than that of the previous year and had spread centrifugally from the site of the original attack!" The curative measures suggested by me that boys should be put on to search for the covered ways and take out the insects from them and kill them were at once put into force. Mr Fischer wrote, :—Almost from the beginning the impossibility of destroying all the larvæ became evident, as the flexibility of the topmost branches prevented their being climbed. The destruction was, however, persisted in for a time in the hopes of making a considerable impression on the invading hordes : . . . When, early in October, after the destruction of over 63,000 larvæ no appreciable diminution in numbers had been effected, the urgency for more drastic measures became apparent. Sanction was obtained to depart from the provisions of the working plan by abandoning the felling of the year's coupe and cutting out all infected trees wherever found throughout the plantations." The poles cut out were transported to a neighbouring lake and immersed for several days. Owing to want of labour some difficulty was experienced in getting this work done quickly, so that some of the larvæ may have got back on to standing trees at night. In all about 25,000 trees were felled. It was hoped that this action had stamped out the attack. "In August 1904, however, the first covered ways of the new generation were observed. At first this was put down to a few trees attacked last year being overlooked, but this was soon seen not to account for the entire fresh outbreak." A patch of Casuarina of about an acre in extent, belonging to villagers, is situated close to the plantations, and this was overlooked in 1903 though attacked by the Arbela. Mr. Fischer appears to think that the 1904 attack spread from this into the Government plantations and he is probably correct as the moths probably flew across the small intervening space to lay their eggs on the trees in the large forests. The new attack, he stated, was not, however, very severe and was soon restricted in its spread: and that this was so was undoubtedly due to his prompt action the year previously.

Mr. Fischer has discovered that the larva feeds upon the bark of many grove and avenue trees in the vicinity of the attacked plantations in Chatrapur. He mentions the following :—Acacia leucophlœa, Acacia arabica, Holarrhœna antidysenterica, Anogeissus latifolia, Millettia auriculata and Eucalyptus globulus (one).

Protection.—My inspection at Chatrapur enabled me to suggest a remedy to Mr. Fischer. We have seen that larvæ are to be found between December and June, and that during this period or portions of it they are to be found in covered ways on the bark of the trees, only leaving these to bore down into the wood to change into the chrysalis state. I would suggest that the larvæ be searched for and killed during the period they are feeding upon the trees. The covered ways are very visible, and each fresh one should be carefully pulled to pieces and the larva taken out and killed. Boys in charge of a watcher could be put on for this purpose. The watcher would first count the number of covered ways upon a tree and then send up the boy to take out the caterpillars, and the number of these latter should tally with the number of covered ways counted and the boy be paid accordingly. The covered ways should be pulled off the bark only after the caterpillar has been taken out. In the cases where they coalesce the operation should be done carefully, so as to make certain of taking all the caterpillars. If any of these latter escape they will soon construct a fresh covered way and continue their depredations. A kerosene tin with some kerosene mixed with water at the bottom will form a convenient receptacle in which to throw the caterpillars. This work should be started as soon as the new covered ways are seen to be making their appearance on the trees; and if done carefully and systematically throughout the plantations, I see no reason why it should not be possible to stamp out this pest or reduce its numbers to such proportions as will no longer endanger the plantations.*

* Since this was written Mr. Fischer has shown that this method is not sufficient when the attack is on the scale of the 1903-04 one. Such, however, will in all probability be very rare and ordinarily the above measures, if undertaken in a thorough and efficient manner, should suffice to keep the plantations clean.

Points in the life-history requiring further observation.

1. Where the eggs are laid and how. Are they laid singly or in patches. How many are laid by one moth?
2. When do the caterpillars first hatch out from the eggs in districts infected south of Ganjam?
3. Length of time spent in the larval state south of Ganjam.
4. Length of time spent in the pupal state.
5. The exact times of appearance of the moths in the different plantations on the East Coast of Madras.

DASYCHIRA sp.

Plate XXVII, fig. 1.

Reference :—Kindly identified by Mr. G. C. Dudgeon as *Dasychira* sp. The specimen bred out was unfortunately deformed, the species being therefore undeterminable.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETERODERA. Family, Noctuidæ.

Tree attacked :—*Abies Webbiana* (Silver Fir).

Description.

Larva.—About 1½ inch in length, densely clothed with long fine silky hairs of a delicate green colour. These hairs entirely conceal the head and abdominal segments of the caterpillar.

Pupa.—Formed within a covering composed of the green hairs of the larva spun together with pale green floss silk. The pupa is 1¼ inch long or a little over, thick anteriorly and tapering posteriorly, being ⅓rd inch across at its thickest part. In colour a dirty white except at upper end, where the white merges into a dark olive-green.

Moth.—A moderate-sized moth with the upper wings a dappled grey with black markings. Lower wings a dark french grey without markings. Pl. XXVII, fig. 1, shows the moth of this species.

Life-History.

The larva is full-grown towards the end of May, when it is to be found feeding upon silver fir needles. It pupates about this period, spinning a beautiful large silken cocoon of the finest floss silk with which its own hairs are woven up. A specimen which pupated in a glass-topped box 3½ inches × 2½ inches in size filled half the box with this silken covering. The pupal stage lasts about three weeks, the moth issuing about the middle of June.

It is possible that there is a second generation in the year, but this has not yet been observed.

A larva taken full-grown on the 22nd May changed to a pupa on the 24th, and issued as a moth on the 15th June.

Locality from where reported.

This insect was found by the writer in the Jaunsar forests, North-Western Himalayas. Elevation, 8,000 feet.

Relations to the Forest.

The larva feeds upon the needles of the silver fir, commencing at the apex and eating down to near the base. It appears to attack the needles in patches, feeding upon leaves contiguous to one another.

As yet it has only been found upon young saplings.

Points in the life-history requiring further observation.

1. Where the eggs are laid.
2. When the larvæ found full-fed towards the end of May hatch out from the egg. This will give the length of time spent in this stage.
3. When and where the June moth lays her eggs.
4. Is there a second generation of the insect in the year? If so, length of time spent in its larval, pupal and imago stages.
5. Where and in which stage the insect passes the winter.

COSMIA OCHREIMARGO, Hmpsn.

Plate XXVII, figs. 2, 2*a*.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Noctuidæ.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Larva.—Head pale greyish-green, small, shining. Body a bright apple-green. Two greyish-green patches on dorsal surface of prothorax. Last segment greyish-green, as also are thoracic and pro-legs. Two minute black spots mark the spiracles (breathing openings) at sides of segments 1 to 11. Segments 2 and 3 have a transverse row of minute brown spots dorsally, and there are a few on the dorsal surface of segments 4-6. Length 1½ inch.

Pupa.—Dark-brown to black, stout, rather shining. Five abdominal segments visible. Skin anteriorly thick. Length ¾th to 1 inch. Width at thoracic end ¼th inch. The pupa is shown in Pl. XXVII, fig. 2.

Moth.—A stout yellowish-brown insect. Head yellowish-brown, hairy. Antennæ filiform. Forewing brown, irrorated with grey, 3 wavy longitudinal dark lines in outer half with faint whitish blotches between; 5 black spots near anal angle, placed one beneath the other. Under wing yellow with a palish broad brown band in upper half and two smaller blotches above it.

Under surface yellow, most of the interior of upper wing brownish black. *Vide* Pl. XXVII, fig. 2*a*.

Life-History.

The caterpillars of this moth become full-fed about the middle of July. They feed upon the older and larger leaves of the trees, and probably spend some weeks in attaining their

full growth. They are, consequently, when in numbers, a serious defoliating pest. The caterpillar pupates about the third week in the month, and the moth issues some time in August—probably during the first half of the month.

It was found somewhat plentifully upon the trees in July 1902, accompanying the Tineid and numerous Tortrix defoliators. The larva does not spin the leaves together to form a [illegible] the habit of the Tortrices.

Locality from where reported.

This insect was found at Deoban (Jaunsar forests) in the North-West Himalayas. Elevation, 9,300 feet.

Relations to the Forest.

The caterpillars of the Tineid and Noctuid moths were to be found plentifully upon the Kharshu trees in July 1902 together with the several species of Tortrix, etc., described below. The defoliation caused by this coterie of larvæ was serious, some trees having lost all, or nearly all, the new foliage of the year. Every part of the tree was infested.

Points in the life-history requiring further observation.

1. When the eggs are laid and where.
2. The length of time spent by the larvæ feeding upon the trees.
3. The number of generations of the moth in the year.

BISTON SUPPRESSARIA, Guen.

Plate XXVII, figs. 3, 3*a*, 3*b*.

Reference :—Hampson, Fauna Br. Ind. Moths. III., 247, No. 3357.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Geometridæ.

Trees attacked :—*Dodonæa viscosa* (sanatha); *Carissa diffusa* (gorinda); *Bauhinia variegata* (kuliar); *Acacia Catechu* (khair); *Acacia modesta* (phulai), *Rothra tinctoria* (kamila). Hampson also gives *Cassia auriculata* in the Fauna.

Description.

Larva.—Dark green, with dark bands on the segments and a slight sub-lateral line; the spiracles are white, ringed with red and with red centres; the tubercle on the first segment, and the legs, purple. The larva of the female is a paler green. Length 2-2¼ inch. Pl. XXVII, fig. 3, shows this caterpillar at rest on a branch.

Pupa.—Dark reddish brown, short and thick with a blunt posterior end. Length 1¼ inch. See fig. 3*a*.

Moth.—Grey irrorated with black; head ochreous, the proboscis well developed, frons not very hairy; thorax and abdomen with yellow bars. Fore wing with a waved yellow antemedial band; both wings with the outer margins non-crenulate and with irregularly sinuous indistinct yellow medial line excurved beyond cell of forewing; an ill-defined post-medial angled band, with some yellow spots beyond it and often some black suffusion at middle of outer margin of forewing; a marginal series of yellow spots. Exp. ♂ 60-70, ♀ 74-80 millim. Fig. 3*b* shows this insect.

Life-History.[1]

The moth appears on the wing early in September, but it is not at present known when the eggs are laid or where. The

[1] The notes on the life-history of this pest, together with excellent specimens of the larval, pupal and imago stages of the insect itself, were sent to me by Mr. H. A. Hoghton, Conservator of Forests, at the time Deputy Conservator of Forests in charge of the Rawalpindi Division. Mr. Hoghton's observations, extending over a period of three months, are most valuable and have enabled me to form a very fair idea of the life-history of this pest. The chief point remaining is to work out the March to June stages.

caterpillar was first noticed in the middle of July, but it is not unlikely that it is to be found at the beginning of the month or in the latter portion of June. It is a voracious feeder, and becomes full-fed and pupates about the middle of August. About three weeks are passed in the pupal stage, a moth having been obtained on the 10th September from a pupa found about the middle of August.

It is not improbable that this may prove to be the second generation of the pest in the year. If this is so, the larvæ of the first would appear some time during April, pupæ perhaps at the end of the month, and moths late in May. This first generation would thus correspond to that of the Sal looper pest *Boarmia selenaria* of the Siwaliks described in No. 1 of these notes at p. 100. The second generation of the year of this latter pest is as yet unknown, but information obtained is sufficient to make it certain that there is one. As in the case of *B. selenaria* the caterpillars of this insect are voracious feeders, and appear to practically live and feed upon every species they meet, thus completely defoliating whole areas.

Locality from where reported.

This insect has been reported from the forests of the Lower Murree Hills, in the Punjab. Elevation, 3,000 to 4,000 feet.

Hampson gives Kangra, Sikkim, Assam, Calcutta and Ceylon as the previously recorded localities in India.

Relations to the Forest.

This Geometrid appeared in large numbers in the brushwood forests of the Lower Murree Hills in July 1902 and committed a considerable amount of defoliating damage. Mr. Hoghton says that "the attack was first noticed about the middle of July, and by the first week in August sanatha (*Dodonæa viscosa*), gorinda (*Carissa diffusa*) and kuliar (*Bauhinia variegata*) were almost completely defoliated in large patches, the warmer and drier southern slopes being most seriously affected. Khair and phulai (*Acacia Catechu* and *A. modesta*), also kamila (*Rottlera tinctoria*) and some other species, were also attacked, but not to

anything like the extent of the above..... Fortunately they seem to pay most attention to the sanatha, which is of little value and practically irrepressible." A pest of this nature with its great feeding capabilities cannot be looked upon as other than serious in small brushwood forests on dry slopes. The complete defoliation has naturally a much more serious effect on small growth than it would have on high tree forest, and it is probable that were the insect favoured by a series of dry favourable seasons it would commit a very considerable amount of havoc before it was finally again brought down to normal proportions by predaceous animals and insects, etc.

Protection and Remedies.

Mr. Hoghton attributes the attack he reports, and I consider correctly so, to a great deficiency in the rainfall during the preceding winter and up to the time of the appearance of the insects. This being so, however, it is curious that no mention is made of the pest having appeared earlier in the year as an insect of this kind, living at the comparatively low elevation of these hills, would almost certainly have done. One good feature noticed was the great flocks of birds which the presence of so large a number of caterpillars collected together. Mr. Hoghton remarks: "I was glad to see the starlings feeding upon them heavily. I have never before seen such large flocks of these birds in the Lower Murree Hills as I saw when visiting the Daleh Reserve on the 1st August."

No mention is made of any predaceous or parasitic insects having been observed preying upon either the larvæ or pupæ. We require to know something about these before it will be possible to consider remedies. Also where the insect spends the winter and in which stage. It may prove possible to introduce measures to get rid of the eggs if the cold weather is passed in this stage.

Points in the life-history requiring further observation.

1. Where the eggs are laid and when.
2. Length of time spent in the larval stage by the July larvæ.

3. What becomes of the September moth? Does it lay eggs at once, and do these eggs remain unhatched throughout the winter, or do they hatch out at once?
4. If the eggs laid by the September moth hatch out at once, is there an autumn (or third) generation?
5. Is there a spring or first generation, the caterpillars of which would appear at the end of March or early in April; the pupæ and moths in May-June?
6. What predaceous and parasitic insects attack the grub and pupal stages of the pest?

TINEA ? sp.

Pl. XXVII, fig. 4.

Reference :—Provisionally determined as a species of *Tinea*.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Larva.—Pale-green or yellow-green in colour, smooth, somewhat shining, flat with yellowish-green head. Length just under ¾th inch.

Pupa.—Pale green. Anterior end whitish-green, almost translucent. Eyes black, prominent beneath pupal skin, as also are the rudimentary wings. 5-6 ventral abdominal segments visible. Length ½ inch.

Moth.—Head black with black filiform antennæ. Wings orange-yellow with large black blotches forming a kind of chess-board pattern in them. Lower wings light chrome yellow. Expanse of wings ½ inch. Pl. XXVII, fig. 4, shows the moth of this species.

Life-History.

The moth appears on the wing at the end of July or early in August. Partially-grown and full-grown caterpillars were found upon the trees on the 10th July. They feed upon the young leaves spinning them together into a mass in which the excreta and portions of eaten leaf are mixed up in the silk. The larvæ confine themselves to the young leaves and the defoliation accomplished by them appears to be heavy. They pupate towards the middle of July, and about a fortnight is spent in this stage. In pupating the larva spins a loose white silken cocoon and then attaches himself by its anal segment to the leaf and changes to the pupal state. The pupa thus lies along the leaf attached at one end and enclosed in the silken cocoon or covering.

Locality from where reported.

This insect was found defoliating the Kharshu oak at Ooan, in the North-West Himalayas. Elevation, 9,300 feet.

Parasite upon Tinea ? sp.

METEONES sp.

Pl. XXVII, figs. 5, 5*a*.

Reference :—Identified as a species of *Meteones* by Dr. W. H. Ashmead; of the U. S. Museum.

Classification :—Order, HYMENOPTERA. Family, Ichneumonidæ.

Parasitic upon Tinea ? sp.

Description.

Pupal case glistening white, silky, elliptical, consisting of finely and closely spun white silk. Length $\frac{3}{16}$th inch. Pl. XXVII, fig. 5, shows a pupal case or cocoon spun on to the back of an oak leaf.

Imago.—A small fly. Head, thorax and body black, shining. Antennæ black. Wings with a black patch in the upper margin of upper wing. Transparent and irridescent. Length $\frac{1}{8}$th inch. Pl. XXVII, fig. 5*a*, shows the fly.

Life-History.

The grub feeds internally upon the Tineid caterpillar. When full grown it comes to the outside and spins on to the leaf an elliptical cocoon, attaching it by one end. It then pupates within this. The ichneumon fly leaves the cocoon by an opening at the unattached end. A fly was obtained on the 15th July. We have still to ascertain how long it spends in the larval or pupal stages, and how many generations it passes through in the year.

TORTRIX sp. (No. 231).

Reference :—Provisionally named Tortrix sp.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA. Family, Tortricidæ.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Larva.—Head dark brown to black, shining, with a white transverse stripe about ⅓rds down from the anterior edge; this stripe is also present upon the under surface, forming a collar. Body a dark yellow-green, almost olive. Thoracic legs black and shining; pro-legs yellow-green. Ventral surface slightly lighter. Some scattered yellow hairs over body. Length ½ inch.

Pupa.—A dark sepia brown in colour, moderately shining, thick-set anteriorly, tapering posteriorly. Eyes and antennæ of future insect clearly distinguishable beneath the pupal skin. Length just over ⅜ths inch.

Moth.—Small, with a fairly large wing area. Greyish brown. Forewing truncate at outer angle, the brown merging into a golden yellow tinge here. Hindwing silvery, with a narrow fringe. Expanse of wings ¾ths inch. (Described from a poor specimen which got damaged after it had been bred out.)

Life-History.

This moth is to be found on the wing in about the second week of July or, perhaps, a little before. Caterpillars were found seriously defoliating the Kharshu oak at the end of June, and these were pupating on the 30th of the month. The larvæ roll up the young new leaves and feed inside the rolled up portion. Pupation takes place in the rolled-up leaves, or the larva may take advantage of a depression in a leaf and pull a corner of the leaf over this, fixing it down by means of silk. A loose white silk covering is spun within this shelter, and the caterpillar then changes to a pupa within it.

This caterpillar was accompanied in its attack by the smallest of the Tortrices here considered (No. 230), and also by No. 229.

Locality from where reported.

This insect was discovered in Tehri Garhwal, on the ridge above Deota, in the North-West Himalayas. Elevation, 9,200 ft.

TORTRIX sp. (No. 264).

Plate XXVII, figs. 6, 6*a*.

Reference :—Provisionally named Tortrix sp.

Classification :—Order, LEPIDOPTERA Sub-Order, HETEROCERA. Family, Tortricidæ.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Pupa.—Dark brown or yellowish; tapers posteriorly. Length $\frac{7}{16}$ths inch. *Vide* Plate XXVII, fig. 6.

Moth.—Head and thorax brownish; abdomen grey. Antennæ filiform. Forewing yellow; upper margin with a black edge swelling out into thickened patches in two places; costal angle black. A wavy transverse diagonal bar about centre of wing and a narrow one near outer edge. A spot equidistant between these. A faint patch near inner angle. Lower wing greyish; fringe narrow. Wing expanse $\frac{15}{16}$ths inch. Plate XXVII, fig. 6*a*, shows the moth.

Life-History.

The moth appears on the wing during the first fortnight to three weeks of July, and was very abundant in 1902.

The larva feeds upon the Kharshu oak and spins itself up into a leaf to pupate, at about the beginning of July. Pupation lasts about 8 days.

Pupæ were obtained from the leaves of the tree in the second week of the month; but no moths were bred from larvæ, so it is not certain as to which of the several Tortrix larvæ present on the trees changes into this moth. It must have played a large part in the very heavy defoliation the trees underwent as the moths were very plentiful, flying around the oak trees both during the day and night.

Locality from where reported.

This insect was found plentifully in the oak forests at Deoban, North-West Himalayas, in July 1902. Elevation, 9,500 feet.

TINEA? sp. (No. 230).

Plate XXVII, figs. 7, 7*a*.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Larva.—Head small, gamboge-yellow in colour, with a canary-yellow transverse stripe separating it from the prothorax. General colour of rest of grub is either canary-yellow or light-green. Three longitudinal stripes run down the dorsal surface, hiding most of the ground colour; a narrow median one and two broader ones separated from it on either side by a narrow yellow stripe. Anal segment greenish-yellow. Pro-legs yellow, as also are the abdominal ones: but latter are lighter in colour. There are scattered yellow hairs on the segments and head. The larva varies much in colouration. In the bright green varieties the gamboge markings are fainter, the head is nearly black and there is a nearly black transverse dorsal patch on the prothorax. The anal segment is bright green. In others the gamboge is almost madder-brown in colour. Length, full grown ⅜ths inch. This colouration of the larva is practically a mixture of the colours of the upper and under side of the oak leaves which are bright green (when young) on upper surface and a gamboge-yellow on the under.

Pupa.—Dark brown, shining, blunt at the anterior end, pointed at the other. Length ⅓rd inch. The pupa is shown in Pl. XXVII, fig. 7.

Moth.—Small, silvery-grey. Large palpi. Head black and blackish beneath; hind wings silvery grey, fringed. *Vide* Pl. XXVII, fig. 7*a*.

Life-History.

This insect probably appears on the wing some time about the end of July. The caterpillars are full-grown

towards the middle of the month, when they pupate. The time passed in the pupal state is thus from 10 to 13 days. I do not know how long the moth spends on the wing in the forest before egg-laying; nor whether there is more than one generation in the year. It is probable that the eggs are laid upon the twigs of the tree in the axils of the buds. The caterpillars were found in company with other species defoliating the Kharshu oak. They feed by eating irregular patches out of the leaf, usually rolling up the edge of leaf and feeding within it. They apparently consume the young new leaves of the year, and in moving about spin quantities of silk which envelopes the twigs in a network. If disturbed the grub drops from the tree and remains suspended by its silken thread. In feeding upon a leaf it does not touch the mid rib. Its colouration undoubtedly serves as a protection to it whilst upon the leaves.

Locality from where reported.

This insect was discovered in Tehri Garhwal (on Deota Ridge), North-West Himalayas, at an elevation of about 9,000 feet.

YPSOLOPHUS? sp. (271, A.)

Plate XXVII, figs. 8, 8*a*.

Classification :—Order, LEPIDOPTERA. Sub-Order, HETEROCERA.

Tree attacked :—*Quercus semicarpifolia* (Kharshu Oak).

Description.

Pupa.—Small tapering yellowish-brown, Length $\frac{3}{16}$ths inch.

Moth.—Small silvery-grey with long wing fringes. Pl. XXVII, figs. 8, 8*a*, show the pupa and moth of this insect.

Life-History.

I know little about this insect. It was bred out of some leaves in the breeding-box from which the *Meteones sp.* parasitic fly mentioned above was obtained. It was either in its minute caterpillar or pupa stage in the second week in July amongst the Kharshu leaves, and the moth issued soon after the middle of the month.

Relations to the Forest.

The larvæ of these small moths are all defoliators and were heavily defoliating the Kharshu oak in the Jaunsar Division in June-July 1902. They work together or almost so, some apparently maturing slightly before their companions, and the trees rapidly become leafless under their attacks. So numerous were the caterpillars that their droppings could be heard pattering down like a shower of rain. There can be little doubt that this heavy defoliation must have a serious effect upon the vitality of the trees, and it is extremely probable that it adversely affects the maturing power of the seed and consequently of the regeneration of this tree. These smaller caterpillars were more numerous upon the trees than their Noctuid companions.

Points in the life-history requiring further observation.

1. Where the eggs are laid. Is it in the axils of buds?

2. Length of time spent in the larval stage.
3. When does the moth lay its eggs? Is the winter stage passed through as an egg?
4. The number of generations in the year.

LASIOCAMPID LARVA.

Plate XXVII, figs. 9, 9*a*.

Amongst the other defoliating caterpillars of the Kharshu oak at Deoban I obtained a larva which evidently belonged to the *Lasiocampidæ*.

The following is a description of the caterpillar:—

Head large, black. Body black, covered with hair. Thoracic and pro-legs black. Hair arranged in whorls of pencils round the insect. On the first four segments the hairs are yellowish-brown in colour. On the following six the pencils are white, whilst on the last two the hairs are again yellowish-brown. In addition to the pencils there are longer projecting black hairs. Length ¾ths inch. The caterpillar is shown in Pl. XXVII, fig. 9.

I endeavoured to breed moths from these larvæ, but all my specimens were parasitised by the ichneumon flies described below. Fig. 9 shows the larva and 9*a* the dead skin of a larva and a cocoon of one of the parasitic flies alongside of it on the leaf.

The larva feeds upon the leaf by eating patches out of its sides or it consumes the whole of the leaf tissue leaving only the larger veins. It was taken on the 10th July.

Parasites upon the above Lasiocampid Caterpillar.

TRIBE HEMITELINI—GENUS NOVUM.

Plate XXVII, figs. 9*a*, 10.

References:—Provisionally determined by Dr. W. H. Ashmead, of the U. S. Museum.

Classification:—Order, HYMENOPTERA.

Parasitic upon the Lasiocampid *Kharshu* defoliating caterpillar.

Description.

Cocoon.—The grub leaves its host when full-fed and prepares a longish oval greyish-brown cocoon outside and pupates within this. See Pl. XXVII, fig. 9*a*.

Imago.—A small slender fly. Head yellow. Eyes black, large. Antennæ many jointed, not elbowed. Thorax and peduncle yellowish-black. Abdomen orange-brown. Legs long and slender, yellow. Wings membranous, irridescent, with a moderate number of cells in them and a black marginal patch (stigma) on upper one. Length $\frac{1}{16}$ths inch. The fly is shown in fig. 10.

EULOPHUS sp.

Plate. XXVII, fig. 11.

Reference:—Provisionally determined by Dr. W. H. Ashmead, of the U. S. Museum.

Classification:—Order, HYMENOPTERA.

Parasitic upon the Lasiocampid oak-defoliating caterpillar.

Imago.—Much smaller than above. A minute fly, very shining, and dark indigo-green in colour. Wings membranous and irridescent. See Pl. XXVII, fig. 11.

Life-History, etc.

Both of these parasitic flies were bred out of the Lasiocampid caterpillars described above.

The larva of the larger one on becoming full-fed quits the body of its host before it pupates and prepares a small greyish-brown, longish oval cocoon, ¼th inch in length, near the dead caterpillar skin and attached to the food plant by some white silk strands. In this it changes to the pupal state. The cocoon opens by a little lid at one end to let out the fly when it is ready to issue.

In the case of the smaller one the minute larvæ appear to pupate within the insect, and not outside.

The larvæ of both these flies pupated during July, and the adults issued some time in August.

It is probable that these parasites assist largely in keeping down the lasciocampid larvæ.

FULGORID.

Classification:—Order, HEMIPTERA. Family, Fulgoridæ.

Tree attacked:—*Casuarina equisetifolia.*

The writer discovered this insect, which is a small black shining "hopper," clustered on the green branches of the tree at the beginning of July. It was found fairly plentifully both at Waltair and Chatrapur (Ganjam). The insect was in all stages of development, from minute little green specks to larger shining black insects $\frac{1}{16}$th inch in length, but still wingless, to full-fledged winged insects of a greyish-black appearance and $\frac{1}{3}$rd inch in length. The insects feed entirely by suction, and from youngest to oldest had their beaks, of which their mouth-parts consist, embedded in the bark of the branches from which they were engaged in sucking out the sap.

At present nothing more appears to be known about this pest, which has not previously been reported. Observations are required as to when it first makes its appearance in the year and as to how long it is to be found in this manner in all stages of its life-history upon the trees. There is no doubt that it might develop into a serious pest in nurseries and young plantations where, owing to its small size and inconspicuousness, it would probably escape notice for some time.

ICERYA sp.

Classification :—Order, HEMIPTERA. Family, Coccidæ.

Tree attacked :—*Casuarina equisetifolia.*

An examination of the pests at present known attacking the Casuarina in Madras would not be complete without a short mention of another insect discovered on trees in Waltair and Chatrapur. This is a member of the family Coccidæ, which contains so many pests to trees and plants. The insect is white, and in its older stages has a mass of white fluffy substance on its dorsal posterior surface, rendering it fairly conspicuous upon the branches upon which it lives by sucking out the sap.

MONOPHLEBUS sp.

Classification :—Order, HEMIPTERA. Family, Coccidæ.

Tree attacked :—*Casuarina equisetifolia*.

The genus *Monophlebus* may be said to be the forest genus of Coccids, since all the species at present known confine their attacks to woody plants. Both at Waltair, at Chatrapur, and in the Botanical Gardens, Calcutta, a species of *Monophlebus* has been obtained on the Casuarina. It feeds by sucking out the sap of the green shoots, going down to the more woody branches as it grows older. It was quite small at the beginning of July, but had grown considerably by the third week in August. Only the female has as yet been secured, so it is impossible to say what the species is. The female is an oval white fleshy scale, convex above and flat beneath, with three pairs of short black legs and a pair of black antennæ. The male will be a small two-winged black fly. It has not yet been taken, and it is therefore impossible to describe the species.